AN EXAMINATION OF THE ANALYSIS PROCESS UNDERLYING THE DECISION TO INVEST IN RECLAMATION AND DISPOSAL FACILITIES

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ABSTRACT

This thesis examines the way in which decisions about the treatment and disposal of solid waste are analysed in the English counties. The emphasis is on decisions with strategic dimensions rather than on tactical issues relating to plant operations. On the basis of an examination of legislation, government advice to local authorities, and literature from both the political and management sciences, alternative hypothesis sets about the analytical process which might be expected to exist are developed. These hypotheses are then tested, using evidence, drawn from surveys, interviews and field studies. A justification for the use of multiple hypotheses and multiple data sources which centres around the trade off between the precision of a result and its importance is offered in the thesis.

The evidence supports the conclusion that the analysis process in existence can best be viewed as an attempt at rational comprehensive planning but one which is severely constrained in various ways. It is argued that the process is a barrier to both effective and efficient operations.

The final chapters of the thesis adopt a more reformist approach. It is argued that collection and disposal systems should be recombined and that co-operation between county authorities should be encouraged. An appropriate analytical process is also defined.

DECLARATION

It is anticipated that some of the work in this thesis may be published as papers jointly with Mrs Matina Mitchell. Chapters describing data collected with the assistance of Mrs. Mitchell are identified in footnotes.

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1.0 THE WASTE MANAGEMENT PROBLEM

1.1 Introduction

a) Historical Background

Before the towns grew up there was no waste management problem. Each man's refuse could be disposed of in the near vicinity in a useful way as fertiliser for whatever ground he had available for cultivation. Such activity probably had its place even in the early towns, since even there developments persisted in linking each house with its own piece of land. However, as population grew, this kind of useful disposal process ceased to operate and the pattern developed of dumping into gutters running along the centres of streets. Final disposal was then probably effected by burning or by the activities of whatever animals were present in the towns (White-Hunt, 1980).

It cannot have been long before the hazards of using fire as a refuse disposal method impinged on town dwellers, and other methods of coping with the refuse disposal problem were sought. In London, for example, a law was enacted in 1297 which required householders to keep their own frontages clear, and by 1354 in that city a weekly refuse collection and disposal system was in operation (White-Hunt, 1981a). The system was simple; the Beadle of each ward employed assistants, known as rakers, who loaded refuse which had been dumped into the streets into horse drawn carts and took it to laystalls, dumps located on the outskirts of the city. Refuse from the laystalls was either

sold to farmers and the like or taken downstream in boats to be dumped in the Essex marshes (GLC, 1975). An examination of much current disposal practice shows that this was an idea centuries ahead of its time, a truly modern solution! (that is of course unless current disposal practices are centuries behind the times). The modernity of the waste management system that operated in London is further evidenced by an order passed in 1407 which instructed Londoners to keep their refuse indoors until it was collected.

However the institutionalised arrangements were insufficient to meet all of London's needs and the practice of illegal tipping appears to have become rife. In 1414 the Constables and Beadles were forced to declare their willingness to pay informers to gather evidence so that people guilty of illegally tipping rubbish in the streets could be brought to law. The inadequacies of the system described above were temporarily hidden by the after effects of the Great Fire of 1666, but given that the disposal system remained virtually unchanged after that date the effects of its inadequacies were bound to reappear.

Despite the proposals of far-sighted men such as Corbyn Morris, who in 1752 proposed that the entire Metropolitan area should be put under a uniform system of management for refuse disposal purposes, it was not until the passing of the Metropolitan Police Act of 1839 that the streets of London became relatively refuse free. The Act effectively provided legal sanctions against leaving any refuse in London's streets. With the passing of the Public Health Acts of 1875 and 1891 the system of refuse collection achieved essentially its current form. Sanitary authorities were obliged to collect refuse from dwellings on

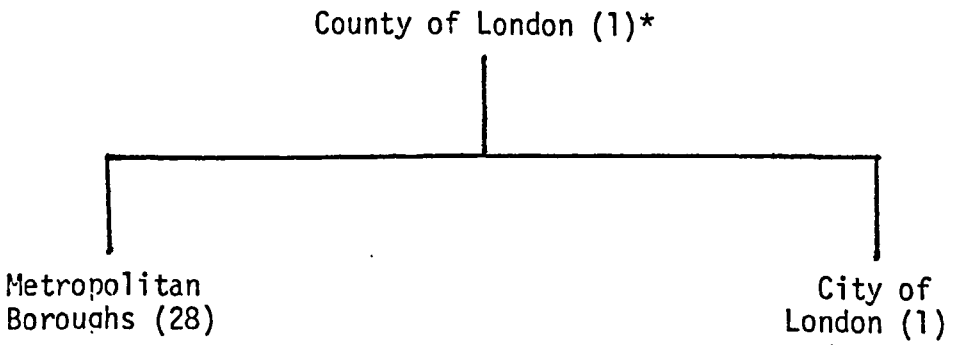
appointed days and occupiers were obliged to keep refuse in a moveable receptacle - in other words a dustbin - to await collection (White-Hunt, 1981b).

b) The Place of Local Government

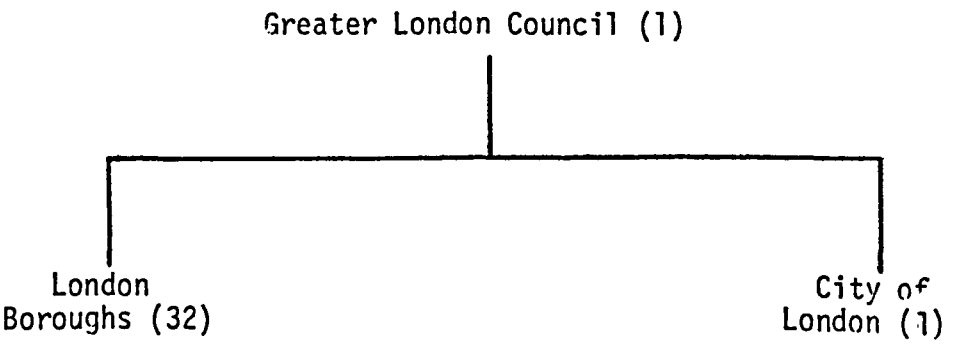
These sanitary authorities were local government bodies and it is mainly in the hands of local government that domestic refuse collection and disposal have remained ever since. This is despite the various local government reorganisations which have occurred. In London the most recent reorganisation followed the London Government Act of 1963. This Act changed the pattern of local government authorities in the London area. The pre and post reorganisation structures are shown in Figure 1.1.1. The 1963 Act also demolished the integrated collection and disposal services which each metropolitan borough and the City of London operated at that time. In the reorganised system the task of refuse collection was entrusted to the 32 London borough councils and the City of London while the Greater London Council became responsible for the disposal of all refuse collected by these authorities.

The effective distribution of tasks along these lines was fully implemented by 1967. The impact of this separation of the collection and disposal functions is an important theme in the study of waste management. It will be returned to over and over again in what follows.

This allocation of the collection and disposal tasks to different levels of local authority was not the normal pattern of operation in England in the 1960's. In the rest of England single authorities



Pre Reorganisation



Post Reorganisation

Figure 1.1.1: The Structure of Local Government in London

* Bracketed figures indicate the number of each type of authority.

continued to have responsibility for both tasks. These single authorities consisted of the county boroughs, non county boroughs, urban districts and rural districts. With the exception of the all purpose county boroughs, county level authorities in the local government framework had no disposal or collection function. This pattern of collection and disposal services persisted outside London until the 1972 Local Government Act. The Act dealt with the structure and function of local government in England and Wales. Only the Greater London area was excluded from its coverage. Here the London Government Act remained in force. As far as England is concerned the pre and post reorganisation structures (excluding London) are shown in Figure 1.1.2. The Act replaced the mix of authorities in existence outside London with a uniform two tier system. Six metropolitan counties, divided internally into thirty-six metropolitan districts, were established. This set of authorities covered the large urban areas of the country. In the rural areas the Act created thirty-nine shire counties. These were split up into 296 districts. As well as changing the local authority structure the Act divided the refuse collection and disposal functions between districts and counties. The districts took on the collection task and the counties the disposal task. Thus the combination of the London Government Act and the Local Government Act established refuse collection and disposal as separately administered activities throughout England.

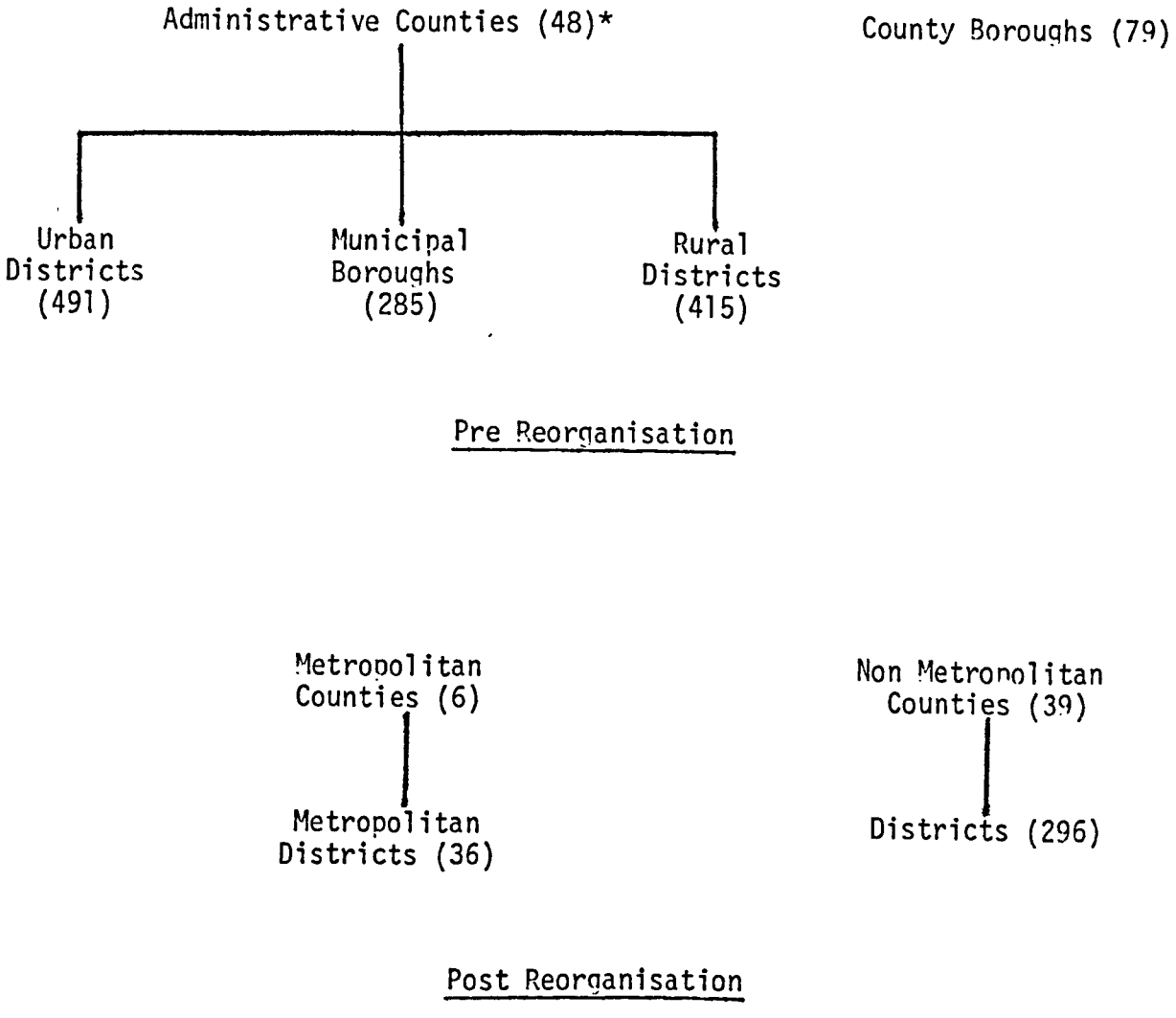


Figure 1.1.2: The Structure of Local Government in England

* Bracketed figures indicate the number of each type of authority.

1.2 The Value of a Management Science Approach to the Waste Management Problem

a) Managerial v Physical Science

As has been indicated, the waste management problem is an inevitable consequence of man's desire to live in communities. Therefore it will not disappear of its own accord and acceptable solutions must be found if the health of the community is to be maintained. There is here a quite fundamental reason why the problem of waste management is worthy of study. The chemist and the engineer must collaborate to develop acceptable collection and disposal technologies. However the question of whether it is worthy of further study based on the managerial rather than physical sciences remains to be answered.

b) Cost Arguments

There are several reasons why such further study is warranted. Firstly disposal and collection are costly operations, and there may be potential cost savings present through the application of new approaches to management. In the financial year 1979/80 revenue expenditure in England and Wales on collection was £343 million (Husband, 1981). Again according to Husband (1981) the equivalent figure for 1978/79 was £280 million.

Not quite comparable statistics for expenditure on revenue account on disposal operations (Local Government Statistics, 1981) indicate that such expenditure probably cost 33% of the collection cost figure in each

year. It should be noted that the costs reported are based on local authority accounting policies. Since they include an element for historical cost depreciation they underestimate the cost of resources used. As far as revenue expenditure is concerned the relative importance of collection and disposal appears to have remained reasonably constant through time. For example, in its evidence to the Royal Commission on Local Government in England, the Ministry of Housing and Local Government felt able to report that of the £43.4 million spent on collection and disposal in 1963/64 disposal probably accounted for 25% of the total (Ministry of Housing and Local Government, 1967). In the financial year 1979/80 expenditure on capital account for collection purposes was approximately £15 million. Disposal related capital expenditure amounted to a further £32 million. The relationship between levels of capital expenditure on collection and disposal is not as clear cut as that for levels of current expenditure. In large part this is due to the dramatic changes in the level of disposal related capital expenditure from year to year. However the tendency is for disposal related expenditure to exceed that for collection purposes.

There are of course other services offered by local authorities which lead to greater costs being incurred, for example education at the county level, and recreation and amenities at the district level. However it is possible that a greater proportion of the refuse management related costs can be saved than is the case for these other services. This is because there appears to be a greater contradiction between management practice and political reality in the waste management field than elsewhere. It can be argued that there is an

over emphasis in waste management practice on maximisation. This is shown particularly clearly by the emphasis on engineering excellence in investment decision-making procedures used by council officers. The approach taken often seems to be to seek the best possible solution in engineering terms subject to the resources available. However given the priority, or rather lack of priority, assigned to waste management by the various political parties a more appropriate approach might well be to minimise resource use in providing an acceptable level of services. It is not always the case that these two approaches will lead to the same solution. This point was made evident by Chapman in his study of the workings of the civil service (Chapman, 1978).

This feeling that there may well be resources to be saved is reinforced by a further argument: waste management tends to be a Cinderella service. The subject does not lend itself to councillor involvement to any extent; it is too technical and, for the most part, uncontentious for that. Clearly this situation increases the possibility that potential savings exist. The emphasis on standards of professional excellence adopted by officers will not be tempered by the elected representatives' knowledge of the particular needs of the local community and therefore excessive use of resources might well occur. This tendency for government provided services to exceed the needs of the community was one of the phenomena reported by Chapman (1978) in his study of the working of the civil service. It is of course possible that elected representatives feel that any benefits which might accrue through their becoming more involved with the waste management problem would not compensate for the costs which would have

to be incurred. In other words they are simply choosing to suffer a level of agency costs. A discussion of the agency cost concept can be found in Jensen and Meckling (1976).

It might also be noted that compared to say education or housing, the subject of waste management is also a Cinderella in terms of the academic attention it gets. In fact, as will be argued later, what academic attention the subject does get is often misguided, dealing as it does with a model of the problem too far removed from reality to be worthwhile.

c) Future Legislation

Cost arguments apart there are other important reasons why this subject area is worthy of further management orientated study. If gain to the community is emphasised, then the potential value of more study to future legislators must be taken into account. At the time of writing all the major political parties appear to see further reform of local government as worthy of consideration. Given that previous reforms were based on folklore about the way the local government sector operates rather than on researched fact, further study at this point in time may well be highly relevant (Dearlove, 1978). A study which attempted to identify the actual consequences of past legislation would surely be of value to those constructing future legislation. Such a study would be of value for academic reasons also. At the present time we lack detailed knowledge of the internal working of local government in general. In the case of waste management it certainly seems possible that published material, emphasising as it

does sophisticated mathematical models, misrepresents the nature of current procedures.

d) Management Techniques and the Political Process

Academic and practical arguments come together once again in identifying a final reason why further study in the waste management field might be valuable: at the present time we lack a study of current procedures which emphasises any impact on the way the local democratic system functions as well as any impact on efficiency. Studies of political arrangements and organisational structures which emphasise impact on the democratic system do of course exist. For example, Seidman (1975, p.177) noted that:

> "government arrangements are not neutral. We do not organise in a vacuum ... Organisational arrangements tend to give some interests, some perspectives, more effective access to those with decision making authority."

However the possibility that a similar point can be made about management processes and tools does not appear to have been widely recognised. It will be argued later that the use or non use of a mathematical programming model or of the discounted cash flow model for example can significantly alter patterns of access to decision-making authority.

1.3 The Current Project

a) Broad Outline

It seems then that further study in the waste management field, based on the methods and findings of the managerial rather than physical sciences, is justified. It remains to specify the nature of the particular study to be undertaken. It is the intention of this work to examine the way in which decisions to invest in waste disposal and reclamation facilities are analysed in the English counties. It is intended that:

(1) Actual analytical processes in use will be described and contrasted with those that feature in the published literature dealing with waste management.

(2) Any technical inadequacies in the processes in use will be highlighted and where possible suggested remedies will be put forward.

(3) The extent to which analytical procedures in use are likely to help or hinder the process of local democracy will be considered.

b) Justification of Emphasis

The emphasis on disposal and reclamation rather than collection might appear illogical given the relative cost of the disposal and collection activities. There might also appear to be a similar

illogicality in the emphasis on analysis of investment rather than operating decisions given the relative magnitudes of capital and revenue expenditures for both collection and disposal purposes. However on both counts appearances are misleading. Investment decisions create the mix of assets which operating policies must come to terms with. A bad investment decision must be lived with for a considerable period of time and changes in operating policy can only mitigate its worst consequences. Similarly disposal decisions define the system of delivery points within which the collection activity must take place and are therefore a key determinant of collection costs.

The emphasis of the study on analytical processes deserves comment. It is stressed that the emphasis is not on decision-making but on the process of analysis leading up to decision-making. The study will examine the extent to which attention is given to objective setting, strategy selection, and forecasting as well as to the more mechanical parts of the process such as the financial evaluation of investment alternatives. The methods used will be identified and the reasons put forward for their use by local authority personnel will be reported. On some occasions the absence of a particular activity will be reported and possible reasons for its absence discussed.

The way in which the outputs of the analytical process are translated into a decision is not the subject of this study. Thus the party political debate, and the activities of interest groups, which accompany and succeed any analysis which takes place will not be considered. This is not to say that these activities are unimportant. Indeed, the role

of political parties in English local government is an important and insufficiently researched topic (Dearlove, 1979). However what will be considered is an equally, if not more important political issue: the extent to which the analytical process hinders or helps the process of local democracy.

c) The Political Dimension

In order to explain the way in which an analytical tool can affect its working, the nature and extent of English local democracy must be understood. The English system of local government is not intended to be democratic in the Aristotelian sense (Aristotle, 1962). There is no provision for all inhabitants of a county or a district to come together to discuss matters of common interest and propose solutions to their common problems. The scale of the modern local government unit and the complexity of the bundle of services offered in the local government framework makes this degree of citizen participation impossible. When the local government system is described as democratic something other than this is meant. It is widely believed that the description implies that the system conforms to the pattern of representative democracy developed in the writings of John Stuart Mill (Mill, 1968). Mill recognises that size constitutes a barrier to participatory democracy and argues that some form of representative government becomes necessary. In effect he argues that politics as well as economics benefits from the introduction of a division of labour: the population elects a representative to carry out the process of political decision-making on its behalf. The key to Mill's idea of representative democracy lies in the political accountability of the

elected representative through free and periodic elections. Theoretically the representative operates in the interests of the populace he represents because of the threat that he will not be reelected if he does otherwise. This view of the local government system as embodying representative democracy is widespread. Given the role that Lord Redcliffe-Maud has played in the recent phase of local government reform, it is particularly interesting that this view underpins the content of a recent text jointly authored by him. He and his co-author, Bruce Wood, argue that (Redcliffe-Maud and Wood, 1974, p.21):

> "Whenever a controversial matter requires decision, a council will test the local climate of opinion before taking action and will have in mind the consequences of taking an unpopular line."

The same authors later state (ibid):

> "... it remains possible to argue that local councils are automatically responsive to local demands and needs ... Indeed if this were not the case, there would be less reason to have local government or spend energies in trying to make it work."

The representative democracy model of local government requires that the elected representatives, the councillors, can ensure that particular decisions are made. If they cannot then the fact that they are ultimately accountable to the electorate is pointless.

However, as was indicated earlier, it is possible that a particular analytical process can assist or frustrate the efforts of councillors to participate in decision-making. Thus the analytical process can interfere with the working of local democracy in a fundamental way.

This view of the potential importance of the analytical process is not dependent on the adoption of the representative democracy model. If, for example, the 'pluralist' model adopted by Dahl is held to be more appropriate, the view that the analytical process can be a key factor is still valid (Dahl, 1961). In the pluralist model the participating section of the electorate is regarded not as an undifferentiated mass but as a set of interest groups. It is conceivable that an analytical process can discriminate between groups in terms of allowing access to the political arena. In other words it is possible that it can fulfill the kind of 'gatekeeper' role which Lukes assigns to an organisational framework (Lukes, 1974).

d) Technology Issues

Finally it is stressed that this is not a study of available technologies for carrying out disposal and reclamation. There already exist many such studies, for example that carried out by David Wilson (Wilson, 1981). The emphasis here is on the way such technologies are viewed during the pre-decision-making appraisal process.

1.4 Potential Benefits

a) Benefits to Management

It is perhaps useful at this stage to identify the potential beneficiaries of the outputs of this study and the benefits that might accrue to them. Hopefully ratepayers and residents will be the long term beneficiaries in the sense that a more appropriate, cost efficient, waste management activity will come into being in the English counties. However such benefits if they occur at all will be long term and indirectly brought about. The main and most direct beneficiaries are likely to be the local authority officers and elected representatives who participate in the analytical process. They should benefit in several ways.

Firstly the comparative study of the waste management function in several authorities which forms part of this study should give them a better insight into what is going on in England than they currently have. This is not to say that information is not currently being exchanged between authorities. However the information is likely to be partial in nature and inevitably somewhat biased in presentation.

A study of the journal produced by the Institute of Solid Waste Management indicates that much of the information exchanged, at least through this channel, tends to deal with the operation of particular disposal or reclamation technologies. Information about management processes is far less frequently exchanged. The value of this comparative information is perhaps indicated by the enthusiastic

response by local authority officers to the workshops organised by the writer over the past two years to allow discussion of preliminary versions of the comparative analyses presented here.

Secondly, the officers and councillors should become more aware of the important role each has to play in the analytical process. At the present time the respective roles of these two participating groups are not clearly understood. The orthodox political literature sees councillors as the initiators of policy and ideas who rely on officers to simply carry out mechanical analyses on their behalf. Collins, Hinings and Walsh emphasise the lack of interest in the officers' role in policy making (Collins, Hining & Walsh, 1976). However such a view ignores the extent to which objective formation and strategy selection are inbuilt in the use of some analytical tools. At the present time it is probably more appropriate to view the officer as the initiator. However neither view appreciates the need for both officers and councillors to participate in the higher level parts of the analytical process such as objective setting.

Thirdly it is hoped that participants in the analytical process will see ways in which their current efforts can be improved. This may occur simply because a new way of carrying out some activity is brought to their attention. However it might also occur because some implicit assumption about the nature of the job they are doing is challenged. Thus they might come to introduce new types of activity into the analytical process they carry out.

b) Legislators

It is hoped that those individuals involved in framing future legislation in the local government sphere will benefit. On the basis of the material contained in this study they should be able to form a picture of the effects of recent reforming legislation and also to see the effect of scale of operations on efficiency and local democracy. In particular they will be able to see some of the consequences of the decision to operate waste disposal and waste collection as two separate functions. It will be argued that they not only separated functions but also severed information flows and links in the command structure necessary for the functioning of the disposal activity.

c) Academics

Finally this study should add to the academic understanding of local government management, both by providing descriptions of current practice and by highlighting the political consequences of management practices and organisational arrangements in this sphere.

NOTES

1. This study focusses on the set of English counties rather than the set of all local authority disposal organisations in Great Britain. However the findings should be of interest to waste management personnel in both Scotland and Wales. The limitation in the set of authorities examined served simply to keep the size of the exercise undertaken within reasonable limits. The exclusion of the Welsh authorities in particular is a source of deep regret.

   In Wales collection and disposal remains an integrated service carried out by district authorities. Clearly an interesting study comparing English and Welsh operations is waiting to be done.

2.0 METHODOLOGY

2.1 Introduction

a) Overview of the Chapter

This chapter serves three purposes. Firstly it attempts to make clear what activities are involved in the "analytical process" which, as was indicated in Chapter 1, is the subject of this study. Content is given to the phrase by linking it to terminology used by other authors, by comparing the activities involved with those involved in systems analysis, and by analysing the advice on waste management planning given by the D.O.E. in terms of "analytical process" activities. The analysis of the D.O.E. advice is emphasised to allow the kinds of questions about the analytical process which are dealt with in this study to be indicated.

The activities involved in the analytical process are presented as linked together in an "analysis circle". The second aim of this chapter is to identify the uses to which this model of the analytical process is put. It is emphasised that it serves as an organising framework for data collection and hypothesis generation and not as a model of what should go on in a county. The obvious link to a rational design process might make it appear that it has a normative role, but this is not the case. Early discussions with waste disposal officers indicated that such a set of activities would be needed to characterise local authority activity.

Finally, the chapter highlights the research approach adopted in this study. It is argued that involvement of several kinds of data collection activity is necessary to provide a valid picture of what is going on in local authorities. The types of data collection activity used are briefly identified.

2.2 The Analytical Process

a) Terminology

This study examines the analytical process which lies behind decisions to invest in waste disposal and reclamation facilities. The phrase 'analytical process' does not in itself adequately define the subject matter of the study. It leaves it unclear whether the subject is merely the set of financial evaluation procedures usually discussed in texts dealing with investment appraisal, for example that by Bierman and Schmidt (1979), or something broader. In fact, for the purposes of this study the 'analytical process' which lies behind the investment decision includes many activities in addition to financial evaluation. Similar sets of activities have been defined by other authors as the 'policy making process' or the 'planning process' (Hambleton, 1978, Faludi, 1973). The activities in fact seem to appear whenever any kind of rational design process is under discussion.

The phrase analytical process has been used here to avoid some of the automatic responses which phrases such as policy formation or planning bring about. For example much local government based literature at the present time sees planning as synonymous with corporate planning, where corporate planning involves taking an overall view of all the activities of the local authority. During the period in which the work underlying this study was carried out, there was little evidence of planning in this sense impinging on waste management activities within a local authority. However some form of planning for waste management was going on.

Similarly if policy formation is under discussion the role of the officer is often denigrated; policy formation is seen as the task of the elected representative while officers simply administer. In this study it is the activities that are of interest no matter who carries them out. It will in fact be argued that much policy formulation is the province of officers rather than elected representatives and that in some respects this is no bad thing.

b) Links with Systems Analysis

As a first step in identifying more clearly the nature of the activities which make up the analytical process this section explores its links with the systems analysis process. A variety of specifications of the components of a systems analysis can be found. However they appear to share a common core. This is well described by de Neufville and Stafford (1971, p.6). They state that:

> "... we can first identify five basic elements of a systematic analysis:
>
> 1. Definition of objectives
> 2. Formulation of measures of effectiveness
> 3. Generation of alternatives
> 4. Evaluation of alternatives
> 5. Selection."

The activities shown in Figure 2.2.1 make up the analytical process which forms the basis of this study. They represent a disaggregation of the phases of activity given by de Neufville and Stafford.

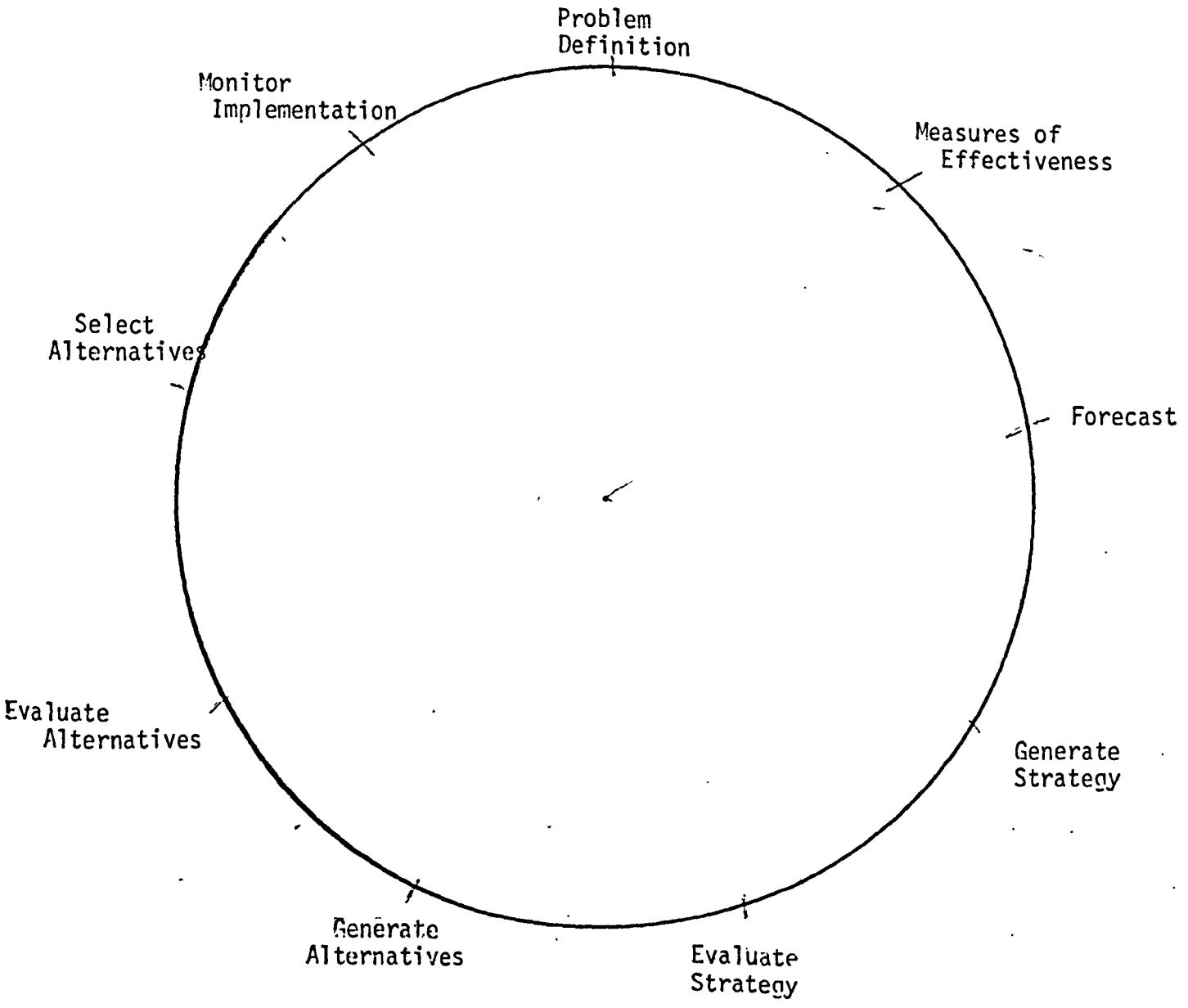


Figure 2.2.1
"The Analysis Circle"

Firstly an implementation monitoring activity has been explicitely included. At first sight this kind of post event analysis activity does not appear to feature in the systems analysis structure defined by de Neufville and Stafford. However its exclusion from the basic set of activities simply reflects their view that it is only one example of the feedback which they see as fundamental to the systems analysis process. They state that (ibid, p.14):

> "Since the time required to implement a large scale project is usually both long and full of uncertainties, the initial analysis results in only a preliminary approximation to the design desirable at the end. It is therefore necessary to refine the plan as the project is installed and as the uncertainties are resolved."

Clearly they have in mind an ability to learn from mistakes, and an ability to apply the fruits of this learning to improve the current decision. It may sometimes be the case that monitoring implementation can lead to revisions of the current decision. A decision which involves a sequence of investments would lend itself to revision in this way. However such monitoring of implementation may only allow lessons to be learned for the next time a similar decision has to be made. This kind of post event audit is an increasingly important feature of much recent, normatively inclined writing in the area of financial management (Brealey and Myers, 1981).

A further disaggregation of the de Neufville and Stafford framework occurs in the area of alternative generation. Figure 2.2.1 indicates that for the purposes of this work, alternative generation is viewed as an activity operating at two levels, the strategic and the tactical. The separate activities are seen as: generation of strategies or broad brush approaches to solving a problem, and generation of alternatives, more detailed specifications of facilities and of locations for facilities which are consistent with particular strategies.

Finally the framework of Figure 2.2.1 differs from that of de Neufville and Stafford in that it explicitly identifies a forecasting exercise. The need for a forecasting exercise or for forecasting exercises is not excluded by de Neufville and Stafford. In fact they later indicate that in their view one of the key issues in carrying out a systems analysis exercise is the selection of forecasting models. They state (ibid, p.15):

> "The questions now raised form the central core of the disagreements that arise over the process of systems analysis ... what models should we choose to estimate future behaviour? How should they be built and how does this construction prejudice the outcome of the analysis? How do simplifying assumptions influence a particular study and which ones should be made?"

c) Links with Planning

For completeness the links between the analytical process described in Figure 2.2.1 and a planning process will now be discussed. It has already been indicated that one reason for describing the subject of this study as an analytical process rather than as a planning process is to make it clear that corporate planning as such is not the subject matter. Another reason for avoiding the term planning is that this term can mean different things to different people.

It is clear that the set of activities described are very similar to the view of what planning is/should be, held by many authors (Banfield, 1959; Ackoff, 1969). However there are other authors who hold very dissimilar views to this. For example Lindblom and his collaborators argue that planning does not proceed rationally in real life and that the kind of rationalist framework outlined here is valueless, Braybrooke and Lindblom, 1963; Lindblom, 1959. Rather than become involved in a debate about whether or not waste disposal groups plan, this study addresses itself to the question of whether activities like those in Figure 2.2.1 go on and to related questions.

2.3 The Analysis Circle in Use

a) A Specific Analytical Process

The analysis circle can be used as a framework within which to analyse different views of appropriate analytical processes. In order to give content to the various stages of the analytical process the view put forward by the D.O.E. will be analysed here (D.O.E., 1976a; 1976c).

b) Problem Definition

Any rational investment analysis must take into account the objectives of the organisation considering the investment. Thus a key factor affecting the way English counties approach the acquisition of disposal and reclamation facilities is the purpose they are attempting to fulfill. Given that the decisions being considered lie within the public sector it might be thought that individual counties have no freedom in this area. However the relevant legislation appears loose enough to allow for different interpretations of the counties' task, and as will be seen, a range of interpretations exists among the English counties. The overall objectives of the English counties as they relate to waste management are important for they can restrict the range of activities which are regarded as suitable. The objective can be so much a part of the waste management scene that it colours even the description of the function; for example it is more common to talk of waste disposal than of waste management or waste reclamation. Levitt has emphasised the importance of understanding the fundamental

objectives of an organisation (Levitt, 1950; 1962). The importance of his argument remains undiminished by the passage of time. An inappropriate definition of objectives can lead to genuine opportunities being identified as irrelevant.

The overall objective on which the advice of the D.O.E. is based can be found in "Waste Management Paper 3" (D.O.E., 1976c, p.2). It states:

> "The overall objective of a waste disposal strategy is the disposal of waste at the least possible cost to the community with due regard to the safeguarding of the environment and the use of waste as a resource."

On this basis the waste management problem has four dimensions, which are in implied order of importance:

1. the overall priority of ensuring that waste is disposed of,

2. the cost of the operation,

3. the environmental consequences of the disposal operation,

4. the potential usefulness of waste as a resource.

There is no indication in the D.O.E.'s discussion that establishing an appropriate objective is part of a local authority's task. As a consequence there is no guidance given as to who should participate

in setting objectives or how frequently fundamental objectives should be re-examined. The implication is that local authorities should inherit their objectives from outside.

In this study attention will be given to the range of objectives in use, the source of those objectives and the frequency with which they are re-evaluated. The consequences of adopting different objectives will also be discussed.

c) Formulate Measures of Effectiveness

Any overall problem definition must be translated into a series of criteria if it is to be possible at a later stage in the analysis to discriminate between investment alternatives. For example the phrase "safeguarding of the environment" which is found in the D.O.E.'s problem definition is not precise enough to discriminate between performance of different waste management facilities. It does not allow comparison between a facility which reduces windblown litter and one which reduces the flow of collection vehicles through a residential area.

The importance of moving to these lower level objectives is stressed in the writings of those decision theorists who emphasise the use of multi-attribute utility theory (Phillips, 1980).. The difficulty of generating this set of lower level objectives is also stressed. The temptation is to identify easily measurable items which do not really reflect the overall objective of the organisation. This 'easy life' argument for using reliable criteria instead of valid criteria is of

course supported by a costs of information argument. The benefits which derive from using valid measures might not be worth the costs involved in creating them.

The description of the analysis process provided by the D.O.E. gives local authorities little guidance as to the importance of these lower level objectives. The need for establishing them is implied in the discussion of the form of planning document suitable for waste management operations which is contained in "Waste Management Paper 3". However the particular lower level objectives selected seem to be seen as likely to be county specific. The extent to which alternative specifications of these criteria can lead to different conclusions being reached is nowhere emphasised.

In this study consideration will be given to the range of lower level criteria in use and the extent to which those in use are both valid and reliable. The appropriateness and availability of alternatives will also be commented on.

d) Forecasting

At its broadest this involves examining the environment within which the organisation is working and identifying those areas in which change is likely. Statistical exercises designed to predict specific variables such as tons of waste an area will produce clearly fall within this view of the forecasting exercise, but so do many others. The D.O.E. view of the activities a waste disposal operation should carry out certainly includes forecast production. In the discussion

of the nature of the activities required by the provisions of the Control of Pollution Act it is stated that (ibid, p.3):

> "The survey will have established the current level and composition of waste arisings, together with a forward look over 10 years."

The D.O.E. appears to see this particular forecasting exercise as being repeated on a regular basis. However no guidance is given as to how such a forecasting exercise is to be carried out. It may be that this is seen as likely to vary between counties. Additionally no guidance is given about the more limited forecasting of costs, for example, which is involved in a financial evaluation of an investment project.

In this study the extent to which forecasts are produced, the variables which are forecast, the time horizons involved, the techniques used and the frequency with which forecasts are produced will all be examined. It will be argued that the nature of the forecasting exercise is frequently misunderstood and that more often than not, forecasting is misused to provide an appearance of spurious certainty when only uncertainty exists (Berry, 1978).

e) Strategy Generation and Evaluation

The high level view of the organisation's problem, together with a view of possible future events, should be sufficient to indicate when further action is likely to be necessary to remedy a potential shortfall in performance. The first stage in identifying a suitable

action is to identify possible strategies. At this stage the concern is not with specifics such as "how many incinerators?", but with more general issues such as whether to incinerate or do something else. It is not necessarily the case that the strategy choice and technology choice should be viewed as synonymous in the waste management field, although this often seems to occur. For example one possible strategy might involve affecting the behaviour of waste producers rather than simply attempting to cope with their product. Another might emphasise sale of waste rather than any kind of treatment. It may be that the outcome of this phase of the analysis circle is a selection of a single strategy. However it is possible that more than one may be carried forward for consideration.

Several issues relating to choice of strategy are discussed in the publications of the D.O.E. The possibility of giving consideration to, alternatives to landfill, reclamation activities, and cooperation with private sector waste disposal operations are all mentioned. No advice is given as to how strategy generation might be carried out by the English counties. The implication is that they are more receivers of suggestions than strategy generators. There is only limited information given about the way strategy evaluation might proceed. The discussion of alternative technologies contained in "Waste Management Paper 1" is of course relevant, but its emphasis on cost factors might be seen as too limited.

In this study attention will be directed towards identifying the range of strategies which are considered and the methods used to generate and evaluate them. No attempt will be made to provide a set of ready-

made comparisons of technologies for waste management officers to draw upon. Such broad comparisons of alternative technologies are available from a variety of sources, for example Wilson (Wilson, 1981).

f) Alternative Generation

At this stage strategies carried forward from the previous stage are given specific content. A range of specific facility types, sizes, and possible locations may be identified; so may methods of controlling the output of waste at source. Clearly local knowledge is important, but equally important may be the negotiating skill of council officers. This may have much to do with whether or not a particular disposal site for example can be regarded as potentially available. Later in this study, the different views about potential site availability in a particular area which were reached by local officers and outside consultants will be commented on. In the particular case discussed, the views of the consultants were found to be so much more pessimistic than those of local officers that the consultants' report was not acted upon. The local officers then demonstrated the superiority of their view by acquiring the landfill sites which the consultants had argued were unavailable.

The D.O.E., once again, sees the survey work required by the Control of Pollution Act as important here. Emphasis is placed on the importance of local knowledge.

In this study attention will be given to the factors which prevent a particular alternative coming into consideration. It will be argued

that a preliminary evaluation takes place on relatively unspecific criteria and that several important trade-offs are made without this fact being recognised.

g) Evaluation of Alternatives

The performance of all alternatives generated is evaluated against the measures of effectiveness which have been defined. It is at this stage of the analysis circle that the models of the management scientist are potentially most relevant.

The advice given by the D.O.E. is quite specific (ibid, p.4):

> "Some of these options may entail capital investment but whether this is so or not is is important that they should be fully evaluated on a consistent basis, using discounted cash flow techniques and the Treasury test discount rate, with account taken of non-financial considerations such as the impact on the environment of the increased traffic flows associated with a particular scheme."

Further equally specific advice is given, most notably that it is acceptable to use constant price costs and revenues in the evaluation since "it makes no difference to the decision rules"! It will be argued elsewhere in this study that this is a gross simplification.

In this study attention will be paid to the range of techniques used for evaluation purposes and the reasons put forward for their use.

The reasons for the absence of certain well-known optimisation techniques will be discussed. It will be pointed out that particular types of misuse of a technique, such as using constant cost data when cost elements are inflating at different rates, can effectively remove certain types of activity from consideration. Reclamation of metals from domestic waste may be regarded as uneconomic for exactly this reason.

h) Selection of Alternatives

One or more of the alternatives are now selected for implementation. It must be stressed that evaluation and selection coincide only under very restrictive conditions. If there is only one important measure of performance then the alternative with the highest rating at the evaluation phase is automatically selected. If there are several relevant performance measures then selection is automatic only if one alternative scores higher on all dimensions of performance than any other. If these rather restrictive conditions are not met then selection is distinct from evaluation. Value judgements must be made and good performance on one measure will have to be weighed against relatively poor performance in other areas. The importance of this distinction between evaluation and selection and the extent to which it is ignored are made clear in the various critiques of cost benefit analysis which have appeared in the literature (Self, 1975).

The D.O.E. do recognise this distinction between evaluation and selection although it is not given much emphasis. Indeed, given the emphasis which is placed on cost figures it seems possible that the distinction is not viewed as highly significant.

In this study consideration will be given to the way selection is carried out and by whom. Alternative approaches will be suggested.

i) Monitoring

Selection is generally followed by action such as attempts at site acquisition. These initial actions, which are designed to bring selected alternatives into existence, may or may not succeed. Failure may be seen as a function of implementation procedures or as due to an inadequate selection of strategy or alternative.

In the terms used by the D.O.E. implementation does not feature significantly in the analysis process. However there is a case for saying that it is one example of the feedback concept which does feature.

In this study the extent to which implementation failures are analysed will be examined and the reasons which are said to lie behind such implementation failures will be discussed. The extent to which such monitoring can be said to lead to remedial action will also be analysed.

2.4 The Analysis Circle is Not an Ideal

a) Valid Uses of the Analysis Circle

An understanding of the way in which this picture of the analytical process has been used in this study is crucial. Its basic roles have been:

1. To organise material for the purposes of comparison between local authorities and between alternative views of 'ideal' analytical processes.

2. To identify areas in which reading should be done and data should be collected.

An example of the first type of use of the analysis circle was given in section 2.3. The use of the analysis circle as a structure to guide data collection will now be discussed. Rather than study everything that happens in managing the waste disposal operations of a local authority, attention was directed at the activities identified in Figure 2.2.1. It can be argued that this establishment of a definition of the analytical process prior to examining exactly what goes on in individual counties will bias research findings. Two potential pitfalls are immediately apparent. Firstly elements of the analytical process being carried out by local authorities which are not included among those identified in Figure 2.2.1 may tend to be overlooked. Secondly, those counties carrying out an analytical process similar to that described in Figure 2.2.1 will be seen as

competent and those doing something different will be seen as incompetent.

The first point has been taken care of during the data collection phase of the research by allowing local authority personnel who have been interviewed to identify at the outset the content of the analytical process they saw themselves as carrying out. Supplementary questions were then directed to them based on the picture of the analytical process set out in Figure 2.2.1.

b) Problems of Establishing an Ideal

The second point assigns a meaning to the picture of the analytical process presented which it does not have. It is not intended as an ideal which all counties should aim to replicate. Indeed it will be argued at various points in this study that the circumstances of different counties can warrant vastly different analytical processes. The fact that a particular local authority apparently ignores one of the activities shown in the analysis circle will certainly be seen as worthy of comment. However it will not be seen as automatically worthy of criticism. In this respect this study differs from many other attempts to deal with management issues in the waste disposal field. A common approach has been to specify an ideal management process and advocate its implementation if current practice seems to differ from the ideal. For example Clark has published a series of articles in the American literature each of which takes this approach (Clark, 1970; Clark and Helms, 1972; Clark and Gillean, 1974). In the UK literature a recent study which leans in this direction is that

by Wilson (Wilson, 1981). In this case the approach advocated is systemic as well as systematic; management is advised to develop a model of the waste management problem based on the ideas of systems theory.

This study has not proceeded by comparing actuality with ideal for a very simple reason. Advocates of ideal systems generally fail to consider various implementation costs which can exist. The introduction of an activity such as forecasting by a local authority, or the introduction of a new way of carrying out an existing activity are likely to be costly. The question always must be asked whether the potential benefits outweigh the costs (Baumol, 1977).

Often major costs relate to the provision of information (Zimmerman, 1979). This basic idea contrasts with the assumption inherent in much management analysis that information is freely and costlessly available. The idea is important because it provides a justification for the continued use of non-optimal procedures and for the allocation of limited resources to particular stages of the analysis cycle. For example Baumol (1977) uses this concept of information cost to account for the continued use of average cost figures for decision making purposes when marginal cost figures are more appropriate. One reason why information may not be freely available is that the information supplier, the information analyst, and the decision maker are more often than not different people. The information analyst may not have control over the activities of the information collector. He may simply have to make do with what is provided. As has been noted in Chapter 1, the reorganisation of local government in England separated the collection

and disposal operations. It will be argued later that it also separated the data collection and data analysis tasks, thus causing major problems for county waste disposal officers.

A more subtle point is that analyst and data collector may have different objectives. This lack of goal congruence may lead to the analyst being provided with inappropriate data. Even though the analyst may have the ability to control the activities of the information collector the costs of doing so may outweigh the benefits gained by having more appropriate information. In this case the analyst is faced with agency costs, costs which derive from a lack of goal congruence between principal and agent, in this case analyst and data collector (Jensen and Meckling, 1976). Harking back to Chapter 1 once again, it may be recalled that such agency costs were also put forward as a possible explanation for the lack of participation by councillors in waste management which was referred to there.

Even when the analyst can control the data collector and lack of goal congruence is not a problem, information costs can arise when new methods of analysis are introduced. The fact that a particular analytical process is in use implies that a compatible information collection process is in operation. Particular kinds of information will be being generated at particular times. The decision to introduce a new activity or a new method of carrying out an activity might require different kinds of information to be provided at different times. Therefore more resources might have to be allocated to information collection. Baumol (1977) gives a simple example of this: the calculation of an average cost figure requires only one data point while the calculation of a marginal cost requires at least two.

In conclusion then, it must be stressed that although an attempt will later be made to identify ways in which existing analytical processes may be improved, it will not take the form of simple advocacy of an ideal.

2.5 The Research Process

a) Problems and Methods

The research problems dealt with in this study can be described quite simply: to find out how an analytical process is being carried out in a group of organisations, to find out why it is being carried out in this way, and to find out how it might be improved.

The last aim, to discover how the analytical process might be improved, further requires that an analysis of the consequences of present methods of working be carried out and also that certain value judgements be introduced.

In the case of the particular organisations being studied, the waste disposal groups in the English counties, little was known by the writer at the start of the research. Consequently the initial work carried out was of an exploratory nature consisting of a literature search and a limited experience survey. The term, exploratory research, is used here in the same way as it is used by Selltiz, Wrightsman and Cook. It is a type of research design which emphasises generation of insights and hypotheses (Selltiz et al, 1976). They contrast this research design with descriptive research, which emphasises calculation of frequencies and correlations, and causal research, which is concerned with the identification of cause and effect relationships.

This initial effort served to indicate that the lack of knowledge was general rather than specific to the writer. It also allowed the

specification of a set of hypotheses relating to the questions, what is happening and why is it happening. However the set of hypotheses dealing with explanations did not lend itself to testing by experimentation, the traditional method of causal analysis. Therefore the research continued to use the methods more appropriate to exploratory and descriptive research designs: literature searches, experience surveys, analysis of selected cases and postal surveys.

The adequacy of exploratory and descriptive research designs for generating hypotheses and for settling questions of fact, such as the type of analytical process being carried out, is generally acknowledged. However the appropriateness of such research designs for dealing with questions of cause and effect such as why particular types of process are in use is much more open to question. Churchill for example states (Churchill, 1979, p.73):

> "Both exploratory and descriptive designs are ... examples of ex post facto research. Ex post facto literally means 'from what is done afterwards' ... One is limited to supplying evidence of concomitant variation in ex post facto research. The lack of evidence regarding the time order of occurrence of variables and the systematic exclusion of other possible explanations of the phenomenon make such designs suspect for establishing causality."

Churchill goes on to argue that experimentation is the research technique best able to determine cause and effect relationships. He acknowledges that the difficulty of establishing control over variables

together with measurement problems makes social science experimentation more difficult than physical science experimentation. However Churchill argues that for some hypotheses these difficulties can be overcome. Unfortunately for the purposes of this study, the more important hypotheses did not fall into this category. A choice then had to be made between testing minor hypotheses with ideal methods and testing major hypotheses with methods which are less than ideal. In the event the option of experimentation was foregone.

The emphasis on using exploratory and descriptive research designs makes possible a choice among the wide variety of research techniques mentioned earlier. The tendency to emphasise one research method to the exclusion of all others is evident in much research in both the physical and social sciences. The argument in favour of this kind of intensive research is that the use of the most appropriate technique will lead to reliable research findings, in the sense that the findings are error free (Stone, 1978). However when the research area is unexplored the task of identifying the most appropriate technique is by no means easy. The possibility is that the painstaking application of one research method may lead to key issues being ignored.

In other words, the research finding, although reliable, will have limited validity - it will not relate to the question of interest.

There is an alternative research methodology, eclectic research (Armstrong, 1978). In eclectic research several research techniques are applied to a problem. Although each technique is applied less

exhaustively than if it had been the only research tool used, the spread of techniques makes it less likely that key issues will be overlooked. Armstrong makes the point in the following way (ibid, p.57):

> "Assume that a hunter is about to shoot at a bird. Unfortunately for him, he cannot see his target directly. However, he does have some idea as to the general location of the target because he saw the bird go into the bush, can hear the bird, and can see some branches moving. Since it is getting late, he decides at this time to try to shoot the bird. The question he now faces is whether to use his rifle or his shotgun ... The rifle is analogous to intensive research. When aimed in exactly the right direction, it does the job with little waste. If not aimed correctly, however, it does little good. The shotgun, analogous to eclectic research, is likely to do some good if aimed in the general direction of the target. It may down the bird or, at least, slow the bird down and allow for a second shot."

Numerous researchers have recommended eclectic research in the social sciences (Cronbach and Meehl, 1955; Cambell and Fiske, 1959; Webb et al, 1966; Cook and Selltiz, 1964; Curtis and Jackson, 1962). Two widely used texts in research methods refer to it - if only as an aside to a major theme (Selltiz et al, 1976; Stone, 1978). However it remains an unemphasised and perhaps to many people an unknown approach. It is possible that the variety of terminology used by

various authors explains this fact; the variety of terms listed in Armstrong for example is enormous.

Despite the fact that eclectic research is not widely used it seems an appropriate strategy for the current research project. There is a high degree of uncertainty about the nature of the analytical processes used by waste disposal groups in the English counties. Similarly the reasons for the selection of particular techniques is far from clear. In these circumstances concentration on say a postal survey to the exclusion of interviews and case studies would be foolhardy. A priori there is no means of knowing which approach will shed most light on the issues involved.

b) Hypothesis Generation

An important element of the research concentrated on establishing hypotheses about the nature of the analytical process in use in waste disposal groups in the English counties. These hypotheses were largely based on the findings of an extensive literature survey. Three types of literature were examined: the texts of various relevant pieces of legislation and various commentaries, consultants' reports on projects carried out for waste disposal groups in the UK local authority sector, literature relating to the waste disposal operation overseas. This literature survey activity continued through much of the research as did the hypothesis generation activity. A small scale experience survey was conducted during the early months of the research to assist in hypothesis generation. The experience survey simply attempts to tap the knowledge of those people familiar with the subject under

investigation who are capable of articulating a point of view. The aim is to generate a variety of viewpoints, rather than to achieve complete coverage of a sample (Selltiz et al, op cit).

c) Hypothesis Testing

Several types of evidence were brought to bear when it came to testing hypothesis. Two major case studies were undertaken in different English counties. On each occasion a piece of analysis was carried out for the waste disposal group in question. However during the research period information was collected which related to the hypotheses under investigation. The writer was then playing two roles during the course of these case studies. He was acting both as a researcher, recording what was going on and what was possible, and as a consultant undertaking a problem solving project. The problems of carrying out this kind of reserach and the ethical issues involved are discussed in Gold and Erikson among others (Gold, 1958; Erikson, 1967). The dual role was not hidden from the main sponsors of the consultancy project. In fact they regarded their willingness to be questioned and observed almost as a fee for the consultancy work. The value of these case studies cannot be overemphasised. Time and time again it was possible to test hypotheses about the way the analytical process worked simply by checking to see whether necessary data was available.

Further evidence was brought to bear on the hypotheses in question in the form of a postal survey of English counties and districts. The survey was carried out with the assistance of a postgraduate student

in the School of Industrial and Business Studies, at the University of Warwick. An analysis of the early responses formed part of this student's MSc dissertation. However a telephone follow-up was carried out by the writer to generate a fuller response and to explore the reasons for certain types of non-response.

Finally, a more extensive experience survey was carried out among waste disposal officers in the English counties. This formed part of an SSRC sponsored research project into planning for waste management. Assistance with the interviewing activity was provided by the writer's Research Fellow, Mrs Matina Mitchell. A brief summary of the material collected has been circulated to the counties involved as a working paper (Berry and Mitchell, 1980).

3.0 THE IMPACT OF LOCAL GOVERNMENT REFORMS

3.1 Introduction

a) Chapter Outline

This chapter contains two major sets of arguments, a body of argument which defines an 'orthodox' view of local government and local government reform, and a critique of that orthodoxy. Each block of argument is used to define a set of hypotheses about the way the analytical process operates in the waste management area. The early part of the chapter provides a justification for the development of two hypothesis sets. The traditional material follows and is succeeded by the critique.

b) The Multiple Hypothesis Approach

The major reforms of local government structure and process which have recently taken place were preceded by a process of evidence collection and debate. This chapter examines the orthodox view about local government which ran through that evidence and debate. The orthodoxy covered diagnoses and remedies as well as criticisms and shaped the resulting legislation. The implications of this resulting legislation for waste management in the English counties are examined and stated as hypotheses about the form of the analytical process in use which are suitable for testing. Caiden (1970) points to the necessity of treating legislation as a body of hypotheses about future behaviour. He states that (Caiden, 1970, p 159):

> "to take reformers at their word is unscientific, certainly distorting. They should be judged by their deeds alone."

The frequent gap between intention and implementation is not the only reason for regarding the output of the legislative process as merely providing guidance about the form of analytical process in use. It is an important characteristic of English local authorities that they have considerable power to decide on their own working methods. Some statutes, for example the Control of Pollution Act, do limit freedom of choice, but much freedom still remains.

In the second half of the chapter, criticisms of the process of reform and of the resulting legislation, which have appeared in the political science literature, are reported and extended. On the basis of this critique an alternative set of hypotheses is generated. Two conflicting hypotheses sets are then available for testing.

Examining alternative hypotheses is not common practice in social science research. It is more common to adopt a set of 'null hypotheses' which is in reality nothing more than a straw man, constructed only for the purpose of being knocked down. Greenwald (1975) presents evidence that this is a favoured approach. This use of a straw man as a null hypothesis leads to nothing more than a search for evidence which will confirm a prior belief. Such a research approach is contrary to the Popperian view that in order to test an hypothesis the search should be for evidence which contradicts current hypotheses (Magee, 1973). In the current research, two reasonable alternative sets of hypotheses are

carried forward. The research task is one of hypothesis elimination. Those hypotheses that remain are considered the most useful.

c) Items to be Considered

This chapter examines the content of certain statutes, statutory instruments, government reports and government circulars. Important political science texts and articles are also dealt with.

Two substantial pieces of legislation in particular will be considered. They are the 1972 Local Government Act and the 1974 Control of Pollution Act. The importance of the Local Government Act was indicated in Chapter 1; it established the structure of local government bodies in existence today and positioned collection and disposal functions in different parts of that structure. The second key piece of legislation, the Control of Pollution Act, affects the way the waste management function is carried out by those local authorities responsible for it. The Act requires that local authorities undertake specific data collection tasks and that they create a waste disposal plan. The Control of Pollution Act is long and detailed and some of its provisions have yet to come into force. Therefore consideration of this Act has to take into account the extent to which statutory instruments, such as commencement orders, have brought its provisions into operation.

The texts of statutes and statutory instruments are not the only documents produced by central government which are relevant to this study. A further important source of central government guidance to local authorities is the mass of reports produced by committees and

commissions established by the government. A good example is the Bains Report on management structure in the post reorganisation local authorities (Bains, 1972). This report contains advice not instructions. However it appears to be established in the minds of officers in local authorities as an important guide to local authority practice. In fact a Department of the Environment Circular recommended local authorities to treat it as such (D.O.E. Circular 121/72). For the purposes of this chapter, the key reports would appear to be the Maud Report (1967), the Redcliffe Maud Report (1969) and the Bains Report (1972).

As can be seen from the preceding paragraph, attention must also be paid to the circulars published by government departments. Generally they consist of an explanation of the content of a statute or statutory instrument. They are aimed at local authorities and similar bodies to assist them in understanding the permissions and obligations which the law creates.

A final set of documents produced under the auspices of the central government which are relevant to this study are the various guides to practice which are sometimes published by government departments. The set of Waste Management Papers published by the Department of the Environment to accompany the Control of Pollution Act is a good example. These particular documents have already been discussed in Chapter 2. The reader will be referred back to this discussion where appropriate.

As well as these central government sponsored documents the political science literature which deals with local government matters will also be examined. In part, this material supports the analysis which

underpins the reforming legislation. However a substantial portion contains the basis of critique of these reforms. This critical strand in the literature is used in the second half of the chapter to establish an alternative set of hypotheses for future consideration.

I. The Orthodox View

3.2 The Traditional View of Local Government Structure

a) Key Issues

The idea that there is a traditional, widely accepted view of the workings and failures of the pre-reorganisation local government structure finds its fullest expression in Dearlove (Dearlove, 1979). Given the critical approach he later adopts, it might be thought that his statement of the traditional view is nothing more than another example of a straw man. However this does not appear to be the case. Major figures who were involved in the process of local government reform also acknowledge the existence of an orthodox view. For example, when discussing the pre-reorganisation system, Redcliffe-Maud and Wood (1974) frequently feel able to refer to "fairly general agreement" as to its weaknesses.

Only a few specific features of this traditional view of the impact of local government structure are of relevance here. Dearlove provides a good reference for other elements. The ideas which are of prime concern here deal with:

1) The links between democracy, effectiveness and size of authority.

2) The existence of conflict between different parts of the local authority structure.

These ideas will now be explored.

b) Democracy, Efficiency and Size

The traditional view of local government was that it was democratic and should be kept so. The 'fact' of its democratic nature was attested to by a wide variety of writers, for example Redlich (1903), Jennings (1947) and Spencer (1971). The basic theme of these writers was that within the local government structure representative democracy was operating through a chain of command involving electors, councillors and officers.

Over the years this view of local government proved surprisingly resistant to a number of formidable challenges. The most serious of these challenges was the apparent apathy of the local government electorate as evidenced by low turnout in elections. Several defences of local government as an example of democracy at work appeared: Maud and Finer (1960) managed to identify non voting with the behaviour of an electorate about to switch allegiance between parties; Sharpe (1962) suggested that such non voting was involuntary, and Hill (1970) suggested that it could reflect contentment with the present state of affairs.

The feeling that the democratic nature of local government should be maintained was expressed equally clearly. Redcliffe-Maud and Wood (1974), in referring to the work of both the Herbert Commissions and the Redcliffe-Maud Commission, argue that the conversion of any part of local government into local administration carried out by civil servants answerable to Whitehall and Westminster would have been inconsistent with the terms of reference of the Commissions. The terms of reference of the Redcliffe-Maud Commission were indeed quite specific on the issue of democracy. The Commission was told to take into account "the need to sustain a viable system of local democracy". This same support for the continuation of a democratic system of local government can be found in a variety of other sources. MacKenzie (1961), Broaden (1970), Richards (1968), and Bristow (1972), all reflect this view.

The traditional view of local government also identified the source of its democratic nature. To paraphrase Schumacher (1973), small was certainly seen as beautiful. This attention to size featured in the works of many authors. Finer (1950), for example, argued that the local knowledge of officials and councillors was a major benefit of local government, and Morris (1960) praised the intimacy of the small local authority. The Local Government Commission for Wales pointed out that (HMSO, 1962, p 70):

> "if convenience were the only factor to be considered all local government would be exercised over very small areas."

The Redcliffe-Maud Commission was not immune to this tendency to identify

the source of democracy in small scale operations. Redcliffe-Maud and Wood state (Redcliffe - Maud and Wood, 1974, p 37):

> "A much more important set of reasons for rejecting massive unitary authorities reflected the commission's concern to achieve 'a viable system of local democracy'."

In the documents produced by the Commission, size was discussed both in terms of population and area.

In a later study, Wood (1976) gave further consideration to this identification of democracy and small authorities. He identified four ways in which the word democracy was used by the Redcliffe-Maud Commission. He argued that democracy was variously seen as requiring a small electorate, a physically small authority in terms of area covered, an authority responsible for important services, and finally decisions being taken as locally as possible. Wood argued that only the first and second uses of the word democracy, entail a link with smallness of size. However it seems more reasonable to see the link as present in all but the third use of the term. In that particular case there is a hint that democracy and effectiveness are similar rather than competitive terms.

The idea that democracy and effectiveness are complementary is very far removed from the traditional view of local government. There was in this view a clear and important trade-off between democracy and effectiveness. Richards reflects this in his comment that the terms of reference of the Redcliffe-Maud Commission contain "a hint of the

perennial conflict between efficiency and democracy" (Richards, 1980, p 40).

This last quotation highlights a potential source of confusion. This is the tendency in the literature to use the terms efficiency and effectiveness interchangeably and loosely. This tendency is noted by both Wood (1976) and Dearlove (1979). Wood notes that the terms of reference of the various commissions which have been referred to were generally stated in terms of a search for effectiveness. He argues that this was so because the distinction between effectiveness and efficiency was not seen as important. He identifies three distinct uses of the term efficiency/effectiveness in the dealings of the Redcliffe-Maud Commission. Firstly the term was linked with decentralisation, secondly with the ability to coordinate, and thirdly with the ability to supervise provision of service. We shall return to this point when a critique of the traditional view is developed. It will be argued then that the distinction between effectiveness and efficiency is important.

Unsurprisingly the issue of size is perceived as being at the root of the conflict between efficiency/effectiveness and democracy. Redcliffe-Maud and Wood (1974) cite as one of the generally perceived weaknesses of the pre-reorganisation system the smallness of many authorities. This they argue prevented the provision of a wide range of high standard services. Their later comment (p 34) that there was no conventional wisdom as to desirable size for an authority should not be taken as indicating a lack of consensus about the relevance of size. As far as efficiency/effectiveness was concerned the popular

view was the opposite of that later propounded by Schumacher (1973) - big was beautiful. Many authors agreed with this view: Robson (1954) argued for increased size to increase efficiency; Griffith (1966) agreed that there were many arguments in favour of larger authorities, and Jackson (1965) identified a preponderant view in the literature that there was a minimum size below which an authority could neither efficiently nor effectively provide services. Morton (1970) argues that the view was prevalent in government circles also. He records that the Redcliffe-Maud Commission was established by a Minister, Richard Crossman, who had no doubt that his feeling that larger local government units were needed would be supported by an impartial body.

At the root of much of the support for large authorities was a belief in the existence of economies of scale. The waste disposal related literature provides a particularly clear example. In its written evidence to the Redcliffe-Maud Commission, the Ministry of Housing and Local Government stated that (HMSO, 1967, p 38):

> "Small scale operations in refuse disposal are uneconomic and inconvenient in various ways. The small authority often cannot afford and certainly has no full time use for expensive mechanical equipment like bulldozers ... When it becomes desirable to use mechanical methods of refuse disposal such as incinerators, because for example adequate tipping space cannot be found, the smaller authorities are again at a disadvantage in that disposal plant cannot be scaled down sufficiently to match their needs."

The Ministry evidence went on to claim economies of scale in pest control and fire control also! Hughes (1967) echoed the Ministry's view that economies of scale exist in the provision of engineering services and went on to argue for the likely existence of administrative economies of scale. While the possibility of these administrative economies was not generally discounted by other writers it struck a less responsive chord. The Redcliffe-Maud Commission was certainly aware of the possibility of managerial problems arising due to the size and complexity of an organisation (Redcliffe-Maud and Wood, 1974, p 37). However this issue was only raised when the possibility of a single all-purpose authority for a major metropolitan area was being considered, and it is not clear that the nature of the problems was understood.

The links between size, democracy and effectiveness are a key element in the traditional view of the pre-reorganisation local government structure. Democracy was seen as present and effectiveness was seen as largely absent. The reformers task was seen as establishing a size of authority sufficiently small for democracy to flourish but large enough to allow for effective and efficient provision of services.

c) Separation of Functions

A further element of the traditional view of the pre-reorganisation local government system was the view that conflict was endemic. Richards (1980) speaks of the history of tensions between counties and the larger county districts. He sees the root cause as a series of ad hoc reforms of local administration which led to a drift of powers away from lower levels of the local authority structure.

Redcliffe-Maud and Wood (1974), however, see a prime cause of conflict in the fact that services were in some cases jointly provided by different authorities. This view is supported by the report of the Redcliffe-Maud Commission and by Minogue (1977).

3.3 The Traditional View of the Management Process

a) Key Issues

The literature contains a clear picture of a traditional view of the process of local government management. Four facets of that traditional view will be discussed here. Dearlove (1979) deals with others. Firstly, the major participants in the management process will be identified and the nature of the relationship between them discussed. Secondly, the structures within an authority, through which the management process operated, will be described. Thirdly, the nature of the policy making process will be looked at, and finally, the extent to which it was seen as characterised by incrementalism will be examined.

b) Participants in the Management Process

Minogue (1977) states that the central problem of internal organisation is the identification of the correct relationship between policy formation and administration and therefore between members and officer. This corresponds to the view expressed by Hart (1968). He states that (Hart, 1968, p 5):

> "The two elements of elected members and permanent officers form the traditional pattern of local government."

As well as identifying councillors and officers as the key participants in the management process, the traditional view also contains the idea that prior to reorganisation antagonism characterised the relationship between them. This is commented on by Gill (1973), and Friend and Jessop (1969), among others. Friend and Jessop, for example, talked in terms of the "fundamental distinction" between salaried professionals and elected officers, while Gill talked about "excessively competitative behaviour" between these groups. The officers were more often than not seen as generating this state of affairs.

c) Internal Structure

Members and officers were seen as operating within a departmental framework with departmental committees being the key organisational feature. The full council was not seen as fulfilling any major role having delegated its decision-making powers to departmental committees. These points were made by a large number of authors including Jewell (1975), Hart (1968), Ripley (1970) and Stanyer (1967). Hart in particular emphasised the role of the committee. He stated that (Hart, 1968, p 128):

> "the committee system is the characteristic mark of local government, just as the Cabinet system is typical of Central Government."

Both departmentalism and the emphasis on management by committee were seen as failings of the local government system. Departmentalism was

seen as leading to fragmentation in policy making, and committees as leading to, among other things, a lack of financial control and a decline in the quality of councillors and officers. Each of these views permeated the report of the Maud Committee.

d) Characteristics of the Policy Making Process

As was indicated earlier, departmental committees rather than the full council were seen as the source of policy decisions. This view was supported by a postal survey of town clerks undertaken for the Maud Committee. Friend and Jessop (1969), however, argued that this view was superficial and that while committees might have appeared to make policy they were in fact merely rubber-stamping the decisions of appointed officers. The Maud report in fact tended to support this view, and argued that the idea that members deal with policy while officers deal with administration was simplistic. The committee report went on to bemoan the fact that this idea continued to have such wide acceptance. Finally the committee report argued that members should accept more responsibility for policy formation while allowing officers significantly more freedom to administer.

Dearlove (1979) argues that the traditional view of local government was ambivalent with regard to the role of the appointed officers. He argues that while the policy forming role of the officer was recognised this did not prevent the view that the scope of official responsibility was too restricted being widely expressed. However it seems possible that these views were not inconsistent and that what was being argued for was a restriction on the activities of members to a very high level policy formation role.

e) Policy Making Style

The traditional view of the manner of policy formation is very clear. It is seen as virtually the antithesis of rational planning. Stewart (1970) identified the key policy question asked as whether or not an activity should be allowed to grow. Such an approach to decision-making clearly leaves little room for policy innovations. Ward argued in a similar vein that (Ward, 1970, p 1):

> "local government has controlled its affairs by making short term projections of the expenditure required to deal with current difficulties and tasks."

Other authors took a similar view. Headrick (1962) , for example, described councils as "drifting" from year to year, while Cossey (1971) talked of the malignant disease of creeping incrementalism. Overall we have a picture of a lack of innovativeness and a high degree of dissatisfaction with this state of affairs. Again this traditional view permeated the report of the Maud committee.

3.4 Traditional Remedies

a) Structural Changes

The pre-reorganisation system of local authorities was seen as inefficient and riven with conflict. This was the thesis of the Redcliffe Maud report and there is no indication that the Labour government which received the report, or the Conservative government

which introduced the resulting legislation disagreed. However, the Commission's recommendations commanded less widespread agreement. Indeed, a substantial minority report was produced by a member of the Commission itself. Therefore it is unsurprising that the legislation which was finally introduced to remedy the perceived defects, the 1972 Local Government Act, included proposals which differed from those put forward by the Commission. The emphasis on increased size of authority and on simplification of structure remained, but the one tier system advocated by Redcliffe-Maud was replaced by a two tier system of local authorities.

The new system was designed to achieve efficiency primarily by reaping economies of scale. Although some small authorities did remain, overall the country was left with a smaller number of larger authorities. In round figures, over 1300 authorities were replaced by 400. As has been said, democracy was seen as a characteristic of local government, therefore the emphasis was on safeguarding rather than introducing this feature. The simplification of the structure was seen as a key factor in achieving this. Additionally, both democracy and efficiency were seen as being enhanced by a rational allocation of functions between the two local authority tiers. The Conservative Government's response to Redcliffe-Maud, which preceded the introduction of the new legislation made this clear. It stated (Cmnd. 4584):

> "The Government's concern has been to settle how functions can best be operated; some need wider areas of administration, while others are best dealt with by authorities more closely in touch with local conditions."

The removal of conflict was potentially more difficult in a two tier structure than might have been the case in the one tier structure reommended by Redcliffe-Maud. It was hoped that the rational allocation of functions between the two tiers and the use of agency arrangements would help achieve this. Under the agency system, a county could devolve down to a district the right to carry out a particular function normally performed by the county and a district could sanction a similar agency arrangement in the reverse direction. Thus, if in some area, a particular function was felt to be mis-allocated, the county and district involved could agree to transfer responsibility for the function in return for payment.

The adoption of a two tier system had a major impact on the way in which waste management was carried out. Prior to reorganisation the refuse collection and disposal functions had been operated as an integrated service. After reorganisation waste disposal was assigned to the county tier and refuse collection to the districts. The shift of the disposal function to the larger scale county units was thought to be necessary to (Richards, 1975, p 122):

> "... utilise more sophisticated techniques of destruction and to promote the recycling of material."

The loss of the disposal function was hotly contested by the pre-reorganisation, non county authorities which were to become the new districts. They argued that cooperation between districts would suffice to bring about what economies of scale were available. The districts were able to command some support in Parliament, and in fact,

during the passage of the Local Government Bill through the Commons, an ammendment restoring disposal to the districts was carried. However this was later reversed by the House of Lords.

b) Process Changes

The establishment of a new kind of local authority requires a major Act of Parliament. Such Acts are landmarks signifying that major change has occurred. No such landmarks exist to signify when change has occurred in the way analytical processes operate within local authorities. To quote Redcliffe-Maud and Wood on the progress of internal reorganisation (Redcliffe-Maud and Wood, 1974, p 87):

> "The Maud and Bains Reports of 1967 and 1972 preface or mark the climax of a period of transition. They may affect the character of subsequent developments, but their influence over the pattern of events is far less clear than that of legislation."

Despite the lack of external landmarks, many writers have felt that change has occurred in the pattern of activities within authorities. Richards, in a rather non specific discussion of the quest for efficiency feels able to state that (Richards, 1980, p 130):

> "New concepts in accountancy and new applications of mathematics are used to produce material which forms a better base for making decisions."

Later, in a similar vein, he comments on the rapid increase in the use of computers in local government. Minogue (1977) makes a similar point, arguing that whether or not change was generated by the various government reports, substantial changes took place in internal organisation and management of local authorities during the 1970s.

Such changes in internal organisation and in the form of the analytical process can have a variety of causes. However one factor must surely have been the impact of government reports and advice, and the enabling aspect of the Local Government Act. Prior to local government reorganisation, local authorities were obliged to establish separate committees to carry out some functions. The 1972 Local Government Act relaxed these statutory obligations and therefore gave local authorities a greater degree of control over patterns of internal organisation than they had had previously. This new freedom allowed local authorities to respond to the promptings of the Maud Report (1967) and the Bains Report (1972) in particular. Both these reports argued for integrative committees established across functions to ensure that fragmented policy making disappeared. A central policy generating committee was a major theme of the reports. Bains further argued for committees capable of monitoring performance. Redcliffe Maud and Wood emphasise that strand of the report which advocated the need to establish priorities and objectives and to measure achievements against expectations. They see this as Bains attempting to escape from "the traditional piecemeal nature of decision-making (Redcliffe-Maud and Wood, 1974, p 85). A final thread in the various government reports was the need to delegate more responsibility to officers. Again the 1972 Act served as a piece of enabling legislation.

c) Process Changes Specific to Waste Management

The waste management operation in the Counties has been exposed to the impact of all the more general factors affecting local authorities. However it has also been subject to specific reform. The 1974 Control of Pollution Act was designed to change the way the waste management function is carried out. The potential impact on the analytical process stems from the provisions of Part 1, section 2 of the Act entitled, "Waste Disposal Plans". This imposed a duty on each waste disposal authority to prepare and periodically revise a waste disposal plan. Previous legislation had contained no such provision. The Act also specified certain data collection and consultation activities to be carried out in the preparation of the plan. Financial factors led to a piecemeal introduction of the various provisions of the Act. The earliest sections of the Act to be brought into force were those which did not involve additional expenditure and those which provided discretionary powers only. These sections, which did not include the planning provisions, took effect on 1st January 1976 (SI 1975 No 2118). However some authorities undertook data collection and planning activities without waiting for the relevant section of the Act to be brought into force. This was recognised by the D.O.E. who made available their Waste Management Paper series to provide guidance (D.O.E. Circular 3/76).

Section 2 of the Act came into force on 1st July 1978 (SI 1977 No 2164). An associated circular made clear that the D.O.E. expected to see substantial progress towards plan completion within two years (D.O.E. Circular 29/78). The selection of a time span was not made by the

Secretary of State under section 2(7) of the Act. As was made clear in the circular, it was no more than a strong suggestion. Despite this, many counties appear to have adopted the suggested time scale as a target. Therefore many planning activities were well under way if not complete, in the sense of a first plan being produced, by 1980. However by that date financial considerations had once again impinged on central government and it had been informally indicated to local authorities that plan completion could be postponed. A formal recognition of the reduced importance being assigned to planning could be found in the provisions of the Local Government, Planning and Land Act 1980. Section 7 of that Act removed from the Secretary of State the power to set a deadline for plan completion which the Control of Pollution Act had conferred.

The likely overall impact of the Control of Pollution Act may well have been weakened by this element of the Local Government, Planning and Land Act. However, despite this implicit downgrading of the importance of planning, the requirement to plan still exists and some planning should have been carried out in most counties.

The planning which has been carried out should have involved consideration of waste reclamation options. Section 2 of the Control of Pollution Act twice makes reference to the issue. A waste disposal authority is compelled by the Act to consider reclamation; it is not simply permitted to but compelled to. Thus the reclamation issue should have featured and should be continuing to feature among the strategies considered by waste management groups.

3.5 Orthodox Hypotheses

a) Existence of an Analytical Process

The impact of the Bains Report (1972) and of the Control of Pollution Act in particular seem to guarantee the existence of a formalised analytical process in local authority groups charged with the waste management function. Therefore the major hypothesis in this area is as follows:

> Major Hypothesis 1
> There is an analytical process in operation in waste management groups in the English counties which bears a strong resemblance to rational planning. That is to say there is a strong emphasis on objective setting and performance monitoring. All the stages of activity identified as part of the analysis circle are likely to be present.

The emphasis in the Control of Pollution Act, and the emphases in the local government literature make it worthwhile to identify three subsidiary hypotheses. These are:

> Subsidiary Hypothesis 1.1
> There is an established procedure for forecasting amounts of waste.
>
> Subsidiary Hypothesis 1.2
> Modern management techniques, such as D.C.F. analysis and the panoply of O.R. techniques, are in use.

Subsidiary Hypothesis 1.3

The reclamation option is actively considered.

b) Impact of the Separation of Collection and Disposal Activities

As far as waste management is concerned the most significant feature of the reorganised local government system which came into operation after 1974 was the split up of the integrated refuse collection and disposal service. Therefore the major hypothesis in this section is as follows:

Major Hypothesis 2

The separation of collection and disposal has no adverse effects on the working of the analytical process. That is to say either disposal can operate as a separate system from collection, or that necessary forms of cooperation between collection and disposal authorities have been established.

Again the literature makes it worthwhile to separate out two subsidiary hypotheses. These are:

Subsidiary Hypothesis 2.1

There is evidence of economies of scale, either engineering or otherwise, in English county waste disposal operations.

Subsidiary Hypothesis 2.2

There is no evidence of diseconomies of scale, managerial or otherwise.

c) Issues of Democracy

Given the emphasis which the orthodox view places on the democratic nature of local government, an additional major hypothesis would seem necessary. This is:

> Major Hypothesis 3
> The analytical process in use enhances the democratic nature of local government. That is to say there is councillor involvement in objective setting and openness to interest groups.

II A Critical View

3.6 A Critique of the Traditionalist View

a) Introduction

The discussion of the traditional view of local government presented earlier in this chapter concentrated on the impact of scale of operation on democracy and effectiveness/efficiency, and on the incrementalist nature of the analytical process. The critique to be presented here will also centre around these issues. The basis of the critique is an examination of the attitude of the traditionalist to the research process.

In this respect, the critique has similarities with that mounted by Dearlove (1979). However, Dearlove draws profoundly pessimistic conclusions about the possibility of any kind of reforming activity in the local government sphere. The conclusion here will be more optimistic, that well managed reform is possible, even if past reforms may not have worked. The discussion of economies of scale also differs significantly from that contained in Dearlove's work.

b) Democracy in Local Government

There is a strand in the local government literature which argues that the democratic ideal so frequently seen in local government operations by traditionalist writers, differed dramatically from reality. Examples of this kind of argument are provided by Rees (1968)

and by Whalen (1960). Other similarly inclined authors have identified arguments why democracy might well be absent. The gap between the picture of the ideal representative and the reality of councillor activity has been pointed out, as has been the possibility that reality corresponds more closely to the "dictatorship of the official" than to the electoral chain of command picture (Newton, 1976). Dearlove (1973) has pointed out that some interest groups may be given preferential access to councillors and officials.

Several arguments can be put forward to reinforce these points of view. For example unconscious preferences by councillors. He argues that among other things the style of communication an interest group adopts can affect the degree of access to the political arena which it achieves. However this may only be half the story. It has already been pointed out that the form of analytical process in use can also fill the role of doorman, in terms of deciding who is, and who is not, to have access to the process of decision-making.

Given that such counter arguments existed in the literature, and given the possibility just demonstrated that it is possible to add to them, why did the traditionalist view continue to hold such a central position in the literature? Dearlove and others argue that a lack of evidence, supporting either traditionalist or alternative views, was the major contributory factor. However an equally important issue would appear to be the tendency to attempt to reconcile contradictory evidence with theory. The treatment of the evidence of voter indifference gives one example of this. Academics and politicians are not exempt from cognitive dissonance it would seem!

In conclusion then the case for the democratic nature of local government would appear to be non proven. There exist alternative views but these have not yet managed to achieve a central position in the debate.

c) Efficiency/Effectiveness

It has been indicated that belief and not evidence underpinned the central role of democracy in the traditional view of local government. The same can be said of the idea that scale and efficiency/effectiveness are related. The evidence of economies of scale in large organisations was singularly lacking. The Redcliffe-Maud Report admitted as much (Redcliffe-Maud, 1969, p 58):

> "... size cannot be statistically proved to have an important effect on performance. There were a few scattered instances where economies of scale appeared to be operating. ... But, in general, size did not seem to have a greater bearing on performance than some environmental characteristics of local authorities."

A similar lack of support for the existence of economies of scale can be found in the various research studies associated with the Commission's report (Rees, 1971). Despite all this the Commission adopted the view that economies of scale were available. The statistical research was defined as having limited relevance and emphasis was placed on the views put forward by government departments. The nature of the view put forward by the Ministry of Housing and Local Government, that in

refuse disposal economies of scale would be present, has already been discussed and it was typical of the tenor of Ministry advice in general.

Is this response by the Commission yet another example of cognitive dissonance or is there something more fundamental at work. The latter appears to be the case. Judging from the information provided by Hood (1976), who was himself one of the Commission's research staff, it was the research process itself which was disliked rather than any particular output of the research. The following quote serves to make the point (Hood, 1976, p 44):

> "Research comes under the list of constraints on the Commission for two main reasons. First because of the misplaced importance attached to it by Crossman (and others) at the time the Commission was established ... A second constraint on the Commission can result from the findings of the researchers. To give a hypothetical example first - what would the commissioners have done had it emerged from the research that only councils of below 10,000 population were efficient? How could this have been incorporated into its recommendations when the public debate had been revolving around the idea of councils much larger than those existing at the time?"

Crossman is seen by Hood as believing that research can "prove" things, whereas (Hood, 1976, p 44):

> "... The Commission did make a major attempt to undertake research into the question of size, but ... at the outset it was clear that 'proof' could only result from a series of value judgements."

As has been stated earlier, research is best seen as an attempt to disprove rather than prove, but even so, Crossman's attitude seems more responsible than that attributed to the Commission by Wood.

Given that evidence was not likely to shake the Commission's view that economies of scale existed, it is useful to examine the a priori probability that they were wrong and that indeed the traditionalist equation of size and efficiency/effectiveness was wrong. Dearlove (1979) states that a misapplication of mainstream microeconomic theory was the source of the idea that economies of scale were a fact of life. He argues that local authorities cannot be operated as one large factory but by their very nature must comprise a number of local units providing a service. Thus he feels that the benefits of division of labour in the workplace are unavailable. He admits the possibility of managerial economies but argues that the possibility of diseconomies are as much a part of modern economics.

Dearlove seems somewhat ill-at-ease with his arguments in this case. Clearly there are some local authority services, and waste disposal might well be one, where a large scale facility could be operated. Thus his argument relates to some services rather than all. Further he does not appear familiar with the nature of the discussion of economies of scale currently appearing in the economics and management

science literature. It is true that textbooks in micro-economics continue to depict the long run average cost curve of the firm as 'U' shaped, displaying economies of scale being replaced by diseconomies of scale as output per period increases. However much research has cast doubt on this form. The empirical evidence, weak though it may be, suggests an 'L' shaped curve. In this case, economies of scale disappear, but are not replaced by diseconomies, at least until scale of operation has gone beyond that which existing operations have experienced. A survey of the research has been provided by Koutsoyiannis (1979). The implication of this research is that for those operations which have been studied there is an absence of either economies or diseconomies over a wide range of outputs. Therefore the selection of scale of operation can be made on non-economic grounds, e.g. if small is democratic, then democracy can be achieved without a sacrifice of economies of scale.

In part the management science literature mirrors the economics literature. There is an awareness that average cost curves, though 'U' shaped can be flat over relevant output ranges. However there is another strand of the literature which argues that a methodology for examining the issue of scale economies has yet to be developed. Tomlinson (1982) states that:

> "Many mistakes have been made in the past (particularly in building too large); no standard reference books exist ... and little serious research appears to be going on or directed towards developing a general methodology."

Tomlinson goes on to identify several factors which past analyses of scale economies have treated in too cavalier a fashion. For example construction of a single large plant prevents any benefits being derived from the learning process which might occur in establishing the capacity in a series of small plants. Further the decision to build a large scale plant may be equivalent to deciding to operate with a short run average cost curve which is 'V' shaped. In this case minimum cost operations will only be possible over a small output range. Therefore, since the decision to build a large scale plant must necessarily be made long before the plant comes into operation, the decision to build a large scale plant involves a significant vote of confidence in whatever forecasting method is used. Accurate, long range, forecasting is then a prerequisite for large scale operation.

Clearly the debate about economies of scale has been, and continues to be, wide ranging. In the context of this debate, the approach taken by the traditionalists towards the possibility of economies of scale in a reorganised system of local government starts to look almost naive. Given the way in which a simple modification of an assumption about the shape of an average cost curve can remove the perceived conflict between democratic organisation and efficient organisation, the unwillingness of the Commission to come to terms with research evidence is disquieting.

One final point needs to be made in discussing the traditional view of efficiency/effectiveness. The lack of consideration given to the distinction between these terms is frightening. Effectiveness deals with the relationship between an objective and an action taken to

achieve the objective. Efficiency deals with the resource cost of undertaking an action. It is possible for an action to be effective, without being efficient, or efficient without being effective. There can be no conflict between democracy and effectiveness if democracy is regarded as desirable since measurement of effectiveness requires an expression of the democratic will.

However there can be a conflict between efficiency and democracy. If some simple objective, such as maintain existing levels and patterns of service, already exists to govern operations, then the collection of opinion to re-define objectives may be seen as inefficient in that it generates an additional use of resources. Efficiency is only a valid objective of a reformer, objections to waste for the sake of waste apart, if effectiveness of operations is ensured.

d) The Analytical Process

The issue of availability of evidence is crucial to the discussion to the traditional view of the internal operations of local government also. To quote Dearlove (1979, p 146):

> "We just do not know enough about how things worked within unreformed local authorities. A bibliography of research studies into the actual practice of local policy-making would be very short indeed ... Movie cameras have rarely been trained on local government and its practices."

True, a variety of insiders put pen to paper to tell what life was like

within a local authority, but their views tended to be either disregarded if they conflicted with the popular view or else accepted uncritically if they supported it. For the rest descriptions of practice tended to reflect what should be rather than what was. Stanyer (1976) in particular has criticised the "excessive legalism" of traditional descriptions. Nor has this tendency died out; Richards' book is a particularly clear example of this approach being applied to the reorganised system (Richards, 1980). So the interplay between officers and councillors, the bad effects of too many committees and excessive departmentalism, the incrementalist style of policy making, all turn out to be unsubstantiated. They may be appealing pictures to a would-be reformer, but they lack support.

However, suppose the picture was true. Is it reasonable to expect that the Bains Report, the Control of Pollution Act and similar measures will have generated change. Dearlove (1979) in his critique of the process of reform argues not. He does so on two grounds. Firstly, he argues that the reforms were rooted in an inadequate understanding of organisation theory and placed too great an emphasis on changing formal structures in the belief that change in process of operation had to follow. Secondly, he argues that the style of rational planning which the reformers sought to introduce is not a feasible method of operation under any circumstances. These arguments will now be examined in turn.

Dearlove sees the reformers as devotees to 'classical' organisation theory. This he sees as a body of principles designed to enable managers to build up a formal structure. Such a body of theory

certainly exists, stretching from the work of Fayol (1916), through Brech (1965) and onward. It emphasises according to Massie (1965), leadership, control and disciplined hierarchy. These are the factors which Davies (1973) for example sees as permeating the Bains Report and even the most cursory reading of the report bears this out: job definitions and organisation charts abound. This reliance of reformers on a theory of organisations can be criticised because the particular theory in question has been successfully challenged. It is now recognised as a partial analysis only, ignoring as it does concepts such as informal organisations and human interaction. Dearlove's argument is that because the theoretical underpinning of the reform movement was so unsound, the reforms will not have had the desired effect. Structures within local government may have changed, but process will not. To some extent, evidence already exists to show that he is correct to believe this. The various surveys of post reorganisation authorities undertaken by the staff of INLOGOV have shown that structural change has not been accompanied by process change (Greenwood et al, 1976).

Dearlove's second theme is that rational planning of the type implied by the Bains Report and the Control of Pollution Act can never come into being. He cites as evidence for this belief the criticisms that have been levelled at various specific examples of rational planning type processes. A particular target is PPBS (Dearlove, 1979, p 177):

> "Fundamentally PPBS sets down a series of steps that should be followed by the rational policy maker. Each of these steps to rational and comprehensive policy making has been subjected to a blow-by-blow critique

which leaves the whole enterprise in intellectual shreds."

A variety of problems are listed: conflict makes objective definition impossible; knowledge of alternatives is limited, complexity and uncertainty are rife. Dearlove's analysis of the reform process is purely negative. He ends with the belief that incremental decision making is all that is achievable given the inherent limitations of the human brain. and that any form of externally imposed organisation is doomed. Evolutionary change of the creeping Darwinian type is the only kind he sees as possible.

Dearlove's analysis certainly provides the basis for drawing up an alternative set of hypotheses about the analytical process operated in waste disposal groups. However, though his conclusions about the fate of recent attempts at reorganisation may appear valid, his conclusions about the impossibility of future reorganisation are not. There are two reasons for this. Firstly, there is no reason why future reform should continue to be based on an obsolete brand of organisational theory. There are alternatives, and there is evidence that these alternatives can lead to successful organisational change. The problems of implementation have been studied and a reform process can be defined which has the potential to succeed. These processes take into account both formal and informal structures and emphasise participation (French, et al, 1966; Child, 1979). Secondly, there are rational approaches to planning which do not require something akin to consensus and perfect knowledge. In these processes, the problems of identifying goals, generating strategies and gaining commitment are recognised as

problem areas. However, solutions based on research have been proposed. The output of these processes may not be utopia, but they do at least allow future desirable states to influence actions rather than the consequences of past decisions. The recommended improvements in analytical process which are suggested later in this thesis are based on this kind of analysis.

In conclusion, the arguments of Dearlove and others form a persuasive basis for the development of an alternative set of hypotheses. However the pessimism about future reform which accompanies them is not so persuasive. Therefore, while accepting the need for an alternative hypothesis set, it seems reasonable to hope that if data collection establishes that there are problems with the way the analysis activity is carried out, remedial action might well be successful.

3.7 Alternative Hypotheses

a) Existence of an Analytical Process

Dearlove has argued that the style of planning advocated in the Bains Report and the Control of Pollution Act is beyond the abilities of anyone to operate. Whether or not this is true, there are arguments which indicate that the desired reforms will not have occurred. Firstly no consideration was given by reformers to ways in which implementation problems might be overcome. Indeed the possibility of implementation problems was hardly discussed. Clearly, then, there is the possibility that any implementation problems met will not have been overcome. Secondly, much of the Control of Pollution Act refers

to production of a plan. Undoubtedly the aim of the Act was to change process, but it is conceivable that a one-off planning document has been produced leaving the underlying process unchanged. Therefore the major hypothesis in this area is as follows:

Major Hypothesis 1

If there is an analytical process in operation in waste management groups in the English counties it bears little resemblance to rational planning. That is to say there is little emphasis on objective setting and performance monitoring. Rather, the process bears a strong resemblance to the incremental style of analysis identified by Lindblom (Lindblom, 1959).

The emphases in the Control of Pollution Act, and the emphases in the local government literature make it worthwhile to identify four subsidiary hypotheses. These are:

Subsidiary Hypothesis 1.1

There is no established procedure for forecasting amounts of waste.

Subsidiary Hypothesis 1.2

Modern management techniques, such as D.C.F. analysis and the panoply of O.R. techniques, are not in use.

Subsidiary Hypothesis 1.3

The reclamation option is largely unconsidered.

Subsidiary Hypothesis 1.4

The requirements of the Control of Pollution Act are seen as requiring production of a document only.

b) Impact of the Separation of Collection and Disposal Activities

As far as waste management is concerned, the most significant feature of the reorganised local government system which came into operation after 1974 was the split up of the integrated refuse collection and disposal service. Therefore the major hypothesis in this section is as follows:

> Major Hypothesis 2
> The separation of collection and disposal has established barriers which make it difficult to operate a rational analytical process. That is to say, either disposal cannot operate as a separate system from collection, or that necessary forms of cooperation between collection and disposal authorities have not been established.

Again, the literature makes it worthwhile to separate out two subsidiary hypotheses. These are:

> Subsidiary Hypothesis 2.1
> There is no evidence of economies of scale, either engineering or otherwise, in English county waste disposal operations.
>
> Subsidiary Hypothesis 2.2
> There is evidence of diseconomies of scale, managerial or otherwise.

c) Issues of Democracy

Given that the democratic nature of local government was probably a figment of the traditionalist imagination, an additional major hypothesis would seem necessary. This is:

> Major Hypothesis 3
> The analytical process in use does not enhance the democratic nature of local government. That is to say there is no councillor improvement and only discriminatory access for interest groups.

4.0 MANAGEMENT SCIENCE MODELS

4.1 Introduction

a) Purpose of the Chapter

In this chapter the management science/operational research literature which deals with the waste management problem will be examined. The aim will be to develop new hypotheses and to refine the ones which have already been developed. At this point the object is not to test hypotheses. The idea is that management scientists, when they build models, make choices and that these choices reflect beliefs about the real world. If the choices can be identified, then the beliefs can be inferred and used to generate hypotheses about the way the world is. If when the hypotheses are tested they are found wanting, this will constitute a serious condemnation of the management science literature.

The chapter begins by identifying both the presence of a common approach in the management science literature dealing with waste, and the nature of the set of choices implicitely or explicitely made during an application of this common approach. Next the range of choice outcomes present in the literature is discussed, with particular attention being given to the work of influential UK analysts. On the basis of this analysis, the hypothesis sets developed in Chapter 3 are then extended.

b) The Management Science Literature: How Much Can It Contribute?

The management science literature includes many references to the waste management problem and therefore. as has been said, it is a potential source of further hypotheses about the way the waste management function is carried out. However the hypotheses are not as strong as those derived from the study of legislation and government advice. The reason for this is simple. The management science literature does not contain descriptions of the way waste disposal officers carry out their duties. Rather it contains descriptions of consultancy exercises and examinations of the relevance of particular mathematical techniques.

It is well known that descriptions of consultancy exercises often have an appearance of precision where the actual exercise had none. Furthermore there is no necessary implication that a consultancy exercise will have an effect on the activities of waste disposal officers. Thus the predictive content of these studies may be slight. The same can be said for the examinations of particular modelling techniques. Many such studies are merely exercises in mathematical manipulation. There is no implication that their content will be immediately applicable to the real life waste management problem. As has been said (Wilson, 1977, p 10):

> "Many authors have been involved in this application of mathematical modelling, not from an interest in the real problems of waste management, but because it may be formulated as an interesting mathematical problem."

Despite this point of view, there may still be some value to be derived from a study of the management science literature, especially that describing consultancy exercises. This is because the management scientist or consultant, when modelling the waste management problem, must make choices. He must choose, among other things, an appropriate mathematical model and an appropriate solution technique and these choices will reflect his view of what is relevant and what is feasible. Wilson (1977, p 41) offers support for this view, but also a warning:

> "The algorithm chosen for model solution depends largely on the assumptions the author is prepared to make about costs and capacities. Alternatively, the opposite may be true, that the algorithm available determines the assumptions made on costs and capacities."

The warning having been noted, the choices made by consultants and modellers, where they can be inferred from the published studies, will be the basis of the hypotheses generated in this chapter.

4.2 Major Themes

a) The Content of the Management Science Literature

The management science literature in the waste disposal field has been the subject of major study over the past few years. Berry and Bacon (1977) have compiled a selective bibliography for the period up to 1976, and Berry (1978) has published a survey article dealing specifically with forecasting for waste management. Wilson has also published several surveys of the literature in this area. However, given that there is considerable overlap in content and conclusion with the study already quoted, this will serve as a standard reference to this author's work.

An examination of Wilson's work, and of the material listed by Berry and Bacon, indicates that there is widespread agreement among authors about the structure of the waste management problem. The bulk of studies see the major decisions as involving selecting locations at which new sinks or trans-shipment facilities can be added to a network. Figure 4.1.1 shows a simple network structure similar to that frequently used. The squares represent locations at which waste is produced, the circles intermediate treatment facilities, and the triangles landfill sites. The lines represent possible routes along which waste can be shipped between locations. Typically in such a network, waste sources outnumber sinks. That is to say, there are many more points at which waste arises than there are at which waste can be disposed of. The typical decision involves locating a new intermediate treatment facility or a landfill site.

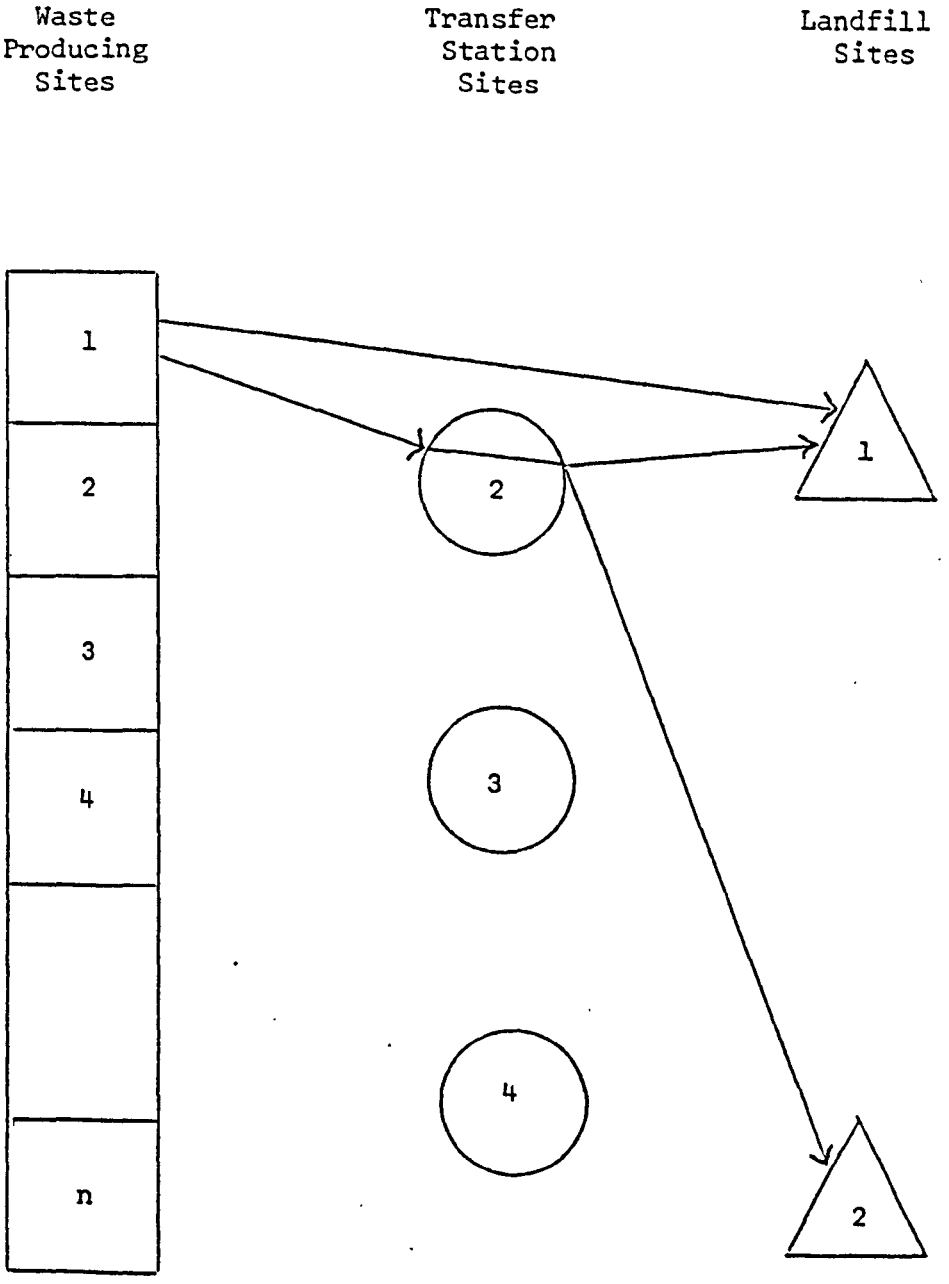


Figure 4.1.1

A Waste Flow Model

4.3 Choices the Analyst Can Make

a) Location Decisions in General

The problem of deciding where to locate a new facility has been widely analysed. The problem is present in both public and private sectors. Rand (1976) has analysed the private sector related literature and has identified seven choices which must be made when constructing a model for the facility location decision. There is no reason to believe that these seven choices disappear as soon as the location decision moves to the public sector. Therefore these choices will be discussed one by one. Any distinctive elements which the waste management situation generates will be identified. Once this has been done, any waste management specific choices will be identified. In later sections the choices advocated or implied by influential UK analysts, such as Wilson and the Local Government Operational Research Unit (LGORU), will be identified. Finally the way these choices relate to the hypothesis sets already generated will be discussed.

Choice of Objective

Rand identifies two possible objectives for the depot location decision. The first is cost minimisation, and the second a return on asset criterion. He argues that the selection of a cost minimisation objective often implicitely assumes that revenue remains constant. In such a case the objective is really one of short-term profit maximisation. The return on asset criterion Rand associates with an analysis which explicitely recognises an investment dimension to the problem.

There is also a choice of objectives when the location for a waste treatment facility is being selected. However the range of possible objectives is even wider. The question of whether to introduce capital costs is of course still relevant, but so are questions of social benefits and also equitable treatment of interest groups. Esmaili (1972) offers an example of a study which concentrates on cost issues. The exclusion of environmental benefits from consideration can, of course, be justified on similar grounds to those used by Rand to justify the exclusion of revenues in private sector studies. Anderson and Nigam (1967) emphasise costs, but they implicitely recognise environmental issues by the use of constraints on activity levels. Finally, Fuertes, Hudson and Marks (1974) provide an example of a study which explicitely deals with the equity issue.

Choice of Admisible Location

Rand indicates that there are two possible approaches to identifying the set of possible locations for a new facility. Firstly a finite number of acceptable locations might be specified on the basis of prior analysis and selection made among these. Alternatively all points in a wide area might be considered possible.

A waste management example may help to make this distinction clear. The first alternative corresponds to a county authority, saying that a landfill sight can be located at Brown's Quarry or White's Quarry and nowhere else in the county, and that therefore the choice is between these two alternatives. The second approach corresponds to a county authority, saying that landfill site can be located without restriction

anywhere in the county. This second approach can be justified on two grounds, either because the new facility can in fact be placed anywhere, or because cost and benefit functions are such that locating the new facility at the nearest feasible point to the optimum identified by the model does not lead to a significant movement from the optimum values of key variables in the objective function.

Wilson (1977) sees the choice between finite and infinite feasible set approaches as a major one in that it has major implications for the search for a solution algorithm. The adoption of the infinite feasible set approach is a feature of Schultz's (1969) analysis of the waste management problem, while a good example of the finite feasible set approach can be found in Harvey and O'Flaherty (1972).

Choice of Search Procedure

There are several algorithms which can be applied to the problem of solving the facility location problem. The previous decision between finite and infinite feasible set approaches is a key factor in choosing one. However other factors are also relevant. One of these is the mathematical sophistication of the potential user of the model. For example, mathematical programming is often seen as less acceptable than simulation as an approach to management problem solving because it is less intuitively obvious. The bulk of Wilson's survey effort goes into cataloguing the range of alternative algorithms which have been suggested (Wilson, 1977).

Choice of Planning Horizon

Rand sees this choice as a key one. Four possibilities can be identified. Firstly the model can be solved for a 'representative' year. Secondly the model can be solved for successive time periods and an overall solution put together by taking common elements from each model run. Thirdly the model can be solved for a single period, which is an aggregate of time periods from the present to the planning horizon. Fourthly time can be dealt with by using a dynamic model in which trade-offs between costs and benefits at different points in time are explicitly introduced. An example off a dynamic model can be found in Fuertes et al (1974) while Anderson and Nigam (1967) provide an example of the more static approach.

Treatment of Present Sites

Rand argues that most location decisions deal with additions to existing networks. Therefore there is a problem about how to deal with existing facilities. They can either be included in the model so that the optimal location for a new facility takes into account the presence of existing facilities, or they can be ignored. There are two possible reasons for selecting this second option. Firstly it may be that there are physical barriers separating the area which the new facility is to deal with from the rest of the network. Secondly writing off the existing facilities may be regarded as an option.

Determination of Capacity

Often there is another dimension to the problem of where to locate a

new facility. That is, how large should the new facility be? Both Rand and Wilson regard the choice of method for answering this question as important. Wilson's treatment of the issue is illuminating. He argues that the various approaches can be viewed as alternative ways of constraining the choices available within the model. The basic case is viewed as one of zero capacity constraints: the model effectively chooses from an infinite set of capacities (Hardy and Grisson, 1976). The second approach is to introduce upper and/or lower capacity limits for facilities (Kuhner and Harrington, 1975). The third approach effectively includes as choice objects within the model a finite set of facilities each one differing from the other only in terms of scale of operation (Haddix, 1975).

Treatment of Local Delivery Costs

Rand is explicitely dealing with a model of a commercial distribution network. His network involves relatively few sources of product, relatively few trans-shipment points and many sinks. He argues that treatment of the costs of moving product from trans-shipment points to sinks is a matter for choice, but that exclusion of these costs is not an option. In the waste management application, local delivery costs are effectively the same as costs of collection. Thus Rand's point is that collection costs are a relevant consideration, but there are different ways in which they can be treated. The key decision is whether to treat them as independent of the facility location decision or as dependent on it. In general, US studies pay most attention to the behaviour of collection costs.

b) Additional Choices

In his analysis of the waste management literature, Wilson places more emphasis than does Rand on the detail of model structures and on solution procedures. By doing so he implicitly identifies two other choice areas. Firstly he argues that there is a wide range of equation forms which can be used to represent cost structures. Secondly he argues that modelling exercises differ in the extent to which sensitivity analysis is advocated. Wilson also identifies as a key issue the decision whether to classify waste by type or to treat it as an homogeneous mass.

There is one other choice area to be dealt with. Implicitely, model choice involves an assumption about the political environment. simple objective functions and an absence of constraints can be taken to imply a belief that a central authority can impose a solution. More complex objective functions and extensive constraint sets can be seen to hint at a perceived need for political compromise.

4.4 The LGORU Approach

a) The Importance of LGORU

LGORU (The Local Government Operational Research Unit) has, since its inception in 1965, carried out a large number of studies of waste management problems for local authorities. The aim of the unit is to provide a strategy evaluation service to local authorities on a consultancy basis. It is not unreasonable to say that most waste disposal officers regard LGORU as the sole purveyor of modelling skills in the waste management field. Given that staff at LGORU have such close links with waste disposal officers it is possible that the choices they make when modelling the problem will mirror reality reasonably well. However, we must remember the caveat entered earlier about the value of consultancy studies.

b) The LGORU Approach

Unfortunately the detail of the LGORU approach has never been carefully recorded. Parker and Portlock (1974) briefly reviewed the stages in the activity, and Nice and Selby (1969) have described the solution algorithm used in one of the models, but a detailed exposition of the approach is unavailable. In what follows these two sources will be supplemented by inferences based on those reports which LGORU have presented to client authorities. Three studies in particular have been used, the North East Hampshire and West Surrey study, the Oxfordshire study, and the South Yorkshire study (Cooper and Roberts, 1971; Roberts and Parker, 1974; Jackson, Renold and Wilson, 1975).

Six stages in a typical LGORU consultancy exercise are identified by Parker and Portlock (1974). These will now be examined.

Calibrating the Model

Local data is collected and used to ensure that the mathematical models used accurately represent conditions in the study area. To quote (Parker and Portlock, 1974, p 24):

> "This data will include population statistics and projections, refuse output, collection round characteristics and methods, manpower and transport costs, existing treatment plant details, volumes and locations of all existing tips, and any local geographical features that might influence the movement of vehicles in the area."

Analysing Tip Requirements

Future total tip requirements in the area are calculated taking into account anticipated increases in population and refuse output per head. This stage apparently involves consultation with a variety of interested parties.

Identifying Treatment Plant Locations

LGORU undertakes a study to identify the optimum number and location of any additional plant which will be required. This activity involves the use of two mathematical models. Both utilise an objective function

based on cost. The first adopts an infinite feasible set approach in selecting otpimal facility locations. Once this model has been run, (Parker and Portlock, 1974, p 26):

> "Practical sites, as near as possible to the optimal locations, are selected during discussion with the authority concerned."

These practical sites are then input to the second model (a transportation type) which calculates the costs of using this particular configuration of facilities.

These two models take into account collection costs, treatment costs, disposal costs and haulage costs. The treatment of collection costs appears to assume that they will not change with a shift in the location of disposal point. That is to say that collection costs are based on existing round structures. It has been argued that (Wilson, 1977, p 44):

> "This restrictive assumption does not admit the possibility of collection round reorganisation and results in a considerable overstatement of the dependence of costs on haul distance."

This is one possible argument. However an alternative is that all LGORU are doing is recognising that disposal authorities cannot control the actions of collection authorities and therefore must assume the worst possible case of no compensating changes when deciding on the introduction of new facilities. The issue of how best to treat collection costs will reappear throughout this discussion.

Developing Practical Strategies

The previous stage of identifying locations for treatment plants apparently deals only with plant of a single type. Therefore at this stage the possibility of a mixed strategy is considered. However the only mix considered appears to involve one type of treatment of waste plus some tipping of untreated waste.

A further feature of this stage is an attempt to calculate any subsidies which the county authority might have to pay to districts to compensate for increased expenditure on haulage in collection vehicles if a new system of disposal locations is introduced. Taking Wilson's point, the districts are likely to be overcompensated, but even so the LGORU approach appears to be reflecting a view of the political system which exists.

Considering Special Collection Methods

This stage appears to be rather mislabelled by Parker and Portlock. It is not the collection operation itself which is being analysed, but the possibility of long haul of waste in collection vehicles. The aim of this stage is to identify best sites for transfer stations. Again a transportation type model appears to be involved.

Using Treatment Facilities Over Time

The sixth and final stage of the LGORU approach attempts to determine how tipping space and treatment facilities should be used over time.

All previous stages seem to be based on a typical year type analysis. Capital costs are annualised to allow such an analysis to be carried out. The shift to a dynamic analysis is achieved by further use of a mathematical model. Again the model is based on the transportation structure. Now however flows of waste through facilities have to be dated.

c) Comments on the LGORU Approach

The adequacy of the LGORU approach will be commented on later in this thesis. The principal concern now is to identify issues which have implications for the hypothesis sets. Of the seven choice areas defined by Rand, only two have not been dealt with in the preceding discussion of the LGORU approach. These are the treatment of existing depots and the treatment of facility capacities. By implication, existing facilities are built into the LGORU models; landfill site capacity obviously is. However facility capacities do not appear to be explicitely treated. Waste flows seem to be the determinant of planned capacity.

These however are relatively trivial points. A more important issue is the lack of reference in the Parker and Portlock outline to any treatment of uncertainty. Wilson also makes this point (Wilson, 1977, p 80):

> "The applied studies of LGORU do not use sensitivity analysis routinely."

Individual studies make reference to the problem, but in a relatively unstructured way. The South Yorkshire study states (Jackson et al, 1975, p vii):

> "Our current philosophy on waste disposal stresses that the ability of alternative disposal methods to adjust to and absorb possible changes in factors affecting disposal should be considered ... In particular, it was suggested that alternative disposal methods should be assessed for their flexibility in relation to changes over time in amount and mix of refuse produced and in external factors, such as changes in interest rates or operating costs."

The study certainly includes data on how cost elements will respond to particular changes, but the nature of the changes examined seems rather ad hoc, and no analysis of total sensitivity is provided. Overall this study still seems to implicitly assume a precision in forecasts which is quite remarkable.

The nature of the political environment implied by the LGORU approach has already been commented on. However the point deserves to be stressed. The county authority certainly seems to be seen as having substantial power to implement decisions, but the existence of other related authorities, principally the districts, is also recognised.

4.5 The Approach of David Wilson

a) Introduction

David Wilson works for the UKAEA at Harwell. He has written several survey papers and a book dealing with the problems of waste management. The book, "Waste Management: Planning, Evaluation, Technologies" is a comprehensive 'how to do it text' aimed at waste disposal officers (Wilson, 1981). The high normative content of Wilson's work perhaps militates against the derivation of hypotheses about what is. However since one strand in his work emphasises applicability, all is perhaps not lost. For simplicity Wilson's earlier study will once again be used as a basic reference where possible (Wilson, 1977).

b) Political Issues in Wilson's Approach

Wilson sees analysis of waste management decisions as having two strands, the political and technical. He sees waste disposal officers, 'the planners', carrying out technical analysis and providing information and advice to the politicians. He sees it as the job of the politicians to set objectives for waste management and to define criteria against which alternatives can be measured. In the light of these objectives and criteria, the planners evaluate and assess technologies. For Wilson there is a significant difference between evaluation and assessment; evaluation involves measurement against criteria while assessment involves selection (Wilson, 1977, p 13). In the light of the findings of technology evaluation and assessment the politicians and the planners develop a strategy (Wilson, 1977, p 14):

> "Strategy generation ... assembles from the most promising technologies, and potential locations, alternative strategies for solving the waste management planning problem. This step obviously requires feedback to the political decision-makers."

Evaluation and assessment of this strategy is once again the province of the planner.

It should be noted that the allocation of functions between politicans and planners leaves assessment, which would seem to be a highly political activity, in the hands of planners not politicians. It must once again be stressed that (Wilson, 1977, p 13):

> "... assessment is the process of making the selection balancing all the criteria."

Although in his flow diagram of the analytical process, Wilson has plan selection, the 'final' stage of the analytical process, back in the hands of the politicians, there must be a question mark hanging over the nature of this activity.

Once a plan has been selected and whatever process of plan refinement is necessary has taken place, the plan must be implemented. While recognising the need for this activity, Wilson pays it little attention perhaps implicitely assuming that implementation is not a problem. There is some support for this interpretation of his views in his identification of the English county with the strong central planning

authority which he thinks most modelling activities assume (Wilson, 1977, p 11).

c) Relevant Costs

Wilson is at pains to point out that multiple criteria can be involved in waste management decision-making. He takes care to explore ways in which performance on several criteria can be displayed. However the more formal aspects of evaluation still seem to be cost based. Relevant costs are seen to be those generated by haulage in collection vehicles, treatment of waste, haulage of residue to final disposal point and disposal. Actual collection costs however seem to fall outside this set of relevant costs. Wilson admits that the boundary between collection and disposal is not clear cut but does seem to imply in his writing that the collection cost consequences should not be considered in disposal decision-making. While this reflects the current UK legislation, it is somewhat surprising given that Wilson later states (Wilson, 1977, p 30):

> "Collection management is essentially an operational planning problem, with extensive reorganisation of collection area boundaries, vehicle routing, crew assignments and the number of trips per day being possible in response to a change in the waste discharge point."

Thus Wilson would seem to be ignoring a set of potential costs and benefits in the analysis of the disposal decision. The implicit

argument appears to be that ignoring such costs is better than assuming that they do not change as LGORU does.

d) The Role of Models

Wilson views models as an aid to the decision-maker rather than as decision-makers themselves. For this reason he sees it as necessary for the planner to be able to understand the simplifications and assumptions inherent in any model which is used. Wilson therefore argues for the use of a hierarchy of models moving from simple to complex. He feels that simple models should be used first and that substantial sensitivity analysis should be carried out. By implication Wilson believes that it will seldom be necessary for the waste planner to move beyond the simpler models.

The emphasis on simplicity does not imply an antagonism towards models on Wilson's part. He sees them as fulfilling an important role in the evaluation process. He states that (Wilson, 1977, p 10):

> "The model provides a systematic means by which the planner can explore the effects of alternative objectives, or the consequences of alternative courses of action, measured as far as possible on a fair basis. This framework allows expert judgement to be brought to bear on the problem, and provides greater insight into the workings of the system."

This statement of the virtues of model use is a curious mixture. There

is the traditional emphasis, to be found in any management science text, on insight, fair measurement and the like. However there is also a political dimension implicit in the idea that 'expert judgement' can be brought to bear by use of a model. Wilson has a clear view of who the experts are (Wilson, 1977, p 21):

> "Perhaps the most powerful argument in favour of a hierarchy of models, beginning with simple analytical methods, is that it returns planning to its rightful position - in the hands of the waste disposal officer."

Perhaps the point that Wilson means to make is that simple models allow waste disposal officers to reassert their primacy over model builders, but where is the elected member in all this?

d) Model Shape

It is difficult to classify Wilson's ideal model using the extended version of Rand's framework used so far. While emphasising the value of models, Wilson does not advocate any specific version. Basically he advocates formal evaluation based on a discounted cost criterion. He argues that a technology comparison on this basis will often be sufficient to identify what should be done. Only when this approach does not yield adequate information should transportation type models be used. Implicitely he advocates a finite feasible set approach, but believes that there will often only be one element in the feasible set.

Wilson's approach to collection costs and his support for sensitivity analysis have already been mentioned and issues such as inclusion of existing depots, and inclusion of capacity costs do not feature in his overall proposal.

In conclusion then, Wilson's approach is based on simple models and sensitivity testing. However the political dimension in his argument should not be overlooked.

4.6 Extensions to the Hypothesis Sets

a) Introduction

The operational research/management science literature which deals with waste management has been examined to see the range of choices which analysts have had to face when dealing with this application area. The prevalence of a location selection approach has allowed the use of the pattern of choices developed by Rand (1976) as the basis of an analytical framework. The pattern of choices was extended to cope with the additional issues specifically introduced by the waste disposal subject area.

Having identified the choices which analysts have to make, and having identified the manner in which two key analysts have dealt with these choices, it only remains to assess the implications for the two sets of hypotheses which were developed in the previous chapter. It must be re-emphasised that at this stage the aim is not hypothesis testing but hypothesis development. The intention is to extend and/or refine the existing hypothesis sets.

b) Hypotheses Dealing with the Nature of the Analysis Process

The first major hypothesis in both 'orthodox' and 'alternative' sets deals with the nature of the analytical process in use in waste management groups. The 'orthodox' version is that the analysis process bears a strong resemblance to rational planning. This 'orthodox' hypothesis is clearly fundamental to the bulk of the analysts whose work

has been examined. The overall emphasis in the literature is on the provision of tools to aid in rational decision-making. This emphasis is consistent with a belief that such tools will be acceptable in the waste management context. This emphasis on 'rationality' certainly seems to inform the LGORU approach.

The 'alternative' version of the major hypothesis in this area is that the analysis process in use will be relatively unstructured and bear little resemblance to rational planning. The piecemeal approach to analysis for waste management outlined by David Wilson links to this. His divide and conquer strategy is unlikely to be acceptable in an environment in which a highly structured planning activity already exists. However the emphasis on objectives distinguishes his approach from Braybrook-Lindblom incrementalism.

Clearly major hypothesis 1 has influential support in both its 'orthodox' and 'alternative' forms. It is therefore an important hypothesis to examine and deserves to be carried forward for further analysis.

Subsidiary hypothesis 1.1 in both 'orthodox' and 'alternative' sets, which deals with the presence or absence of a forecasting exercise, also appears to be significant. The type of model proposed in the literature can only be applied on the basis of forecasts of waste amounts. Therefore in the absence of an established forecasting procedure, much of the management science literature would be irrelevant.

Subsidiary hypothesis 1.2 deals with the use/non use of modern management techniques. Given that the literature dealing with management

science techniques in waste management goes back over twenty years, and given that the application area is now a run of the mill text book example, the 'orthodox' version of this hypothesis must be almost an article of faith among management scientists. Can so much academic management science effort have left the real world totally unchanged?

Subsidiary hypothesis 1.3 deals with the extent to which the reclamation option is considered within the analysis process. The management science literature contains models which identify flows of reclaimed material. However this is not a central theme. Therefore rather than refine this hypothesis to identify different types of reclamation activity, it will be carried forward unchanged.

Within this general area of the nature of the analysis process in use, the management science literature serves to identify several valuable additions to the hypothesis sets. Firstly it is clear that the bulk of the models advocated will be heavy data users. The need for forecasts of waste has already been mentioned, but these forecasts are only one part of the required data set. There is an additional need for a substantial amount of cost data relating to vehicle and disposal facility operations. Subsidiary hypothesis 1.5 will deal with the issue of data availability. The 'orthodox' version will state that a regular and relevant data collection activity is in existence. The 'alternative' will state that data collection activities are crude and intermittent. Secondly the decision to adopt an infinite set or a feasible set approach to the location problem implies a view about the degree of freedom of choice open to local authorities. If site selection is hindered by water authority requirements and for example

the activities of environmental groups, then a finite feasible set approach would appear to make most sense. Hypothesis 1.6 will deal with this issue of freedom of choice. The 'orthodox' version will state that waste disposal groups have available to them a wide variety of sites at which they can locate treatment facilities or disposal operations. The 'alternative' version will state that feasible sites are rare. Finally, the different approaches taken in the literature to the issue of sensitivity testing of models to variations in data inputs, supports hypotheses about the certainty of the future facing waste disposal groups and the precision of their cost and other data. Earlier hypotheses have dealt with the presence/absence of data collection and forecasting activities, but hypothesis 1.7 will deal with the outputs of these exercises. The 'orthodox' version will state that available cost estimates have tight confidence intervals about them and that forecasts of future waste amounts have tight confidence bands around them. The 'alternative' version will state that a high degree of uncertainty surrounds cost parameters and waste amount forecasts. Hypothesis 1.8 expands on this 'alternative' view. This will state that although sources of uncertainty can be identified in both cost estimates and waste forecasts, they are in fact ignored.

The LGORU approach to waste management decision analysis seems firmly rooted in the 'orthodox' versions of these subsidiary hypotheses. Wilson's position is less clear cut. Certainly he would appear to support the 'alternative' version of hypothesis 1.6, but his support for the 'alternative' versions of hypotheses 1.5 and 1.7 is not so clear. His advocacy of simple models to allow sensitivity testing would appear to range him alongside supporters of the 'alternative'

version of 1.7. However he appears also to believe that local records are capable of providing detailed information about the costs of existing operations (Wilson, 1977, p 39).

c) Hypotheses Dealing with the Separation of Collection and Disposal

The major hypothesis in this area, major hypothesis 2, deals with the effect of the separation of collection and disposal on two levels. At one level, the concern is whether disposal can operate without reference to collection. At the second the issue is whether, in the event that the two operations are inextricably linked, necessary forms of cooperation between districts and counties have been established. The bulk of the literature that has been examined takes the view that the collection and disposal systems are linked together. Despite this there are clearly differences in opinion as to how to cope with any interactions. The ideal is obviously to explicitely model the collection consequences of disposal decisions. However the LGORU approach is to assume that collection costs, other than those relating to haul in collection vehicles, will not be changed by the disposal decision. On the other hand, Wilson ignores collection costs other than those related to haul on the grounds that the districts are capable of a flexible response.

LGORU and Wilson are effectively adopting rules of thumb, and this approach seems worthy of further consideration. Therefore two further subsidiary hypotheses will be defined. Hypothesis 2.3 will feature in the 'alternative' hypothesis set, and will state that the need to recognise the response of collection costs to disposal decisions is

being coped with via arbitrary rules of thumb. Hypothesis 2.4 will feature in both 'orthodox' and 'alternative' sets. The 'orthodox' version will state that districts are able to adjust collection procedures in the light of disposal decisions and so minimise collection costs. The 'alternative' version will state that collection costs are sticky in response to disposal decisions.

Two subsidiary hypotheses dealing with economies/diseconomies of scale have already been defined. It should be noted at this stage that if it is established that data collection procedures do not exist within local authorities, these may fall by the wayside.

d) Hypotheses Dealing with the Democratic Process

The major hypothesis in this area, major hypothesis 3, deals with the impact of the analytical process on the workings of local democracy. Various views of the political process have been identified during the analysis of the management science literature. The comments of David Wilson in particular indicate that the relative roles of councillors, officers and model builders deserve consideration. Therefore this hypothesis will be carried forward for further examination.

5.0 Summary of Hypothesis Sets

5.1 Introduction

a) Purpose of the Chapter

This chapter contains little new material. Its principal purpose is to bring together the various hypotheses which have been developed in the previous chapters for ease of reference. However it does introduce one additional hypothesis.

5.2 The Orthodox Hypothesis Set

a) Existence of an Analytical Process

Major Hypothesis 1

There is an analytical process in operation in waste management groups in the English counties which bears a strong resemblance to rational planning. That is to say there is a strong emphasis on objective setting and performance monitoring. All the stages of activity identified as part of the analysis circle are likely to be present.

Subsidiary Hypothesis 1.1

There is an established procedure for forecasting amounts of waste.

Subsidiary Hypothesis 1.2

Modern management techniques, such as D.C.F. analysis and the panoply of OR techniques, are in use.

Subsidiary Hypothesis 1.3

The reclamation option is actively considered.

Subsidiary Hypothesis 1.5

A regular and relevant data collection activity is in existence.

Subsidiary Hypothesis 1.6

Waste disposal groups have available to them a wide variety of sites at which they can locate treatment facilities or disposal operations.

Subsidiary Hypothesis 1.7

Available estimates have tight confidence intervals around them as have forecasts of waste amounts.

b) Impact of the Separation of Collection and Disposal

Major Hypothesis 2

The separation of collection and disposal has no adverse effects on the working of the analytical process. That is to say, either disposal can operate as a separate system from collection, or that necessary forms of cooperation between collection and disposal authorities have been established.

Subsidiary Hypothesis 2.1

There is evidence of economies of scale, either engineering or otherwise, in waste disposal operations.

Subsidiary Hypothesis 2.2

There is no evidence of diseconomies of scale, managerial or otherwise.

Subsidiary Hypothesis 2.4

Districts are able to adjust collection procedures in the light of disposal decisions and so as to minimise collection costs.

c) Issues of Democracy

Major Hypothesis 3

The analytical process in use enhances the democratic nature of local government. That is to say there is councillor involvement in objective setting and openness to interest groups.

5.3 The Alternative Hypothesis Set

a) Existence of an Analytical Process

Major Hypothesis 1

If there is an analytical process in operation in waste management groups in the English counties it bears little resemblance to rational planning. That is to say there is little emphasis on objective setting and performance monitoring. Rather, the process bears a strong resemblance to the incremental style of analysis identified by Lindblom (Lindblom, 1959).

Subsidiary Hypothesis 1.1

There is no established procedure for forecasting amounts of waste.

Subsidiary Hypothesis 1.2

Modern management techniques, such as D.C.F. analysis and the panoply of OR techniques, are not in use.

Subsidiary Hypothesis 1.3

The reclamation option is largely unconsidered.

Subsidiary Hypothesis 1.4

The requirements of the Control of Pollution Act are seen as requiring production of a document only.

Subsidiary Hypothesis 1.5

Data collection activities are crude and intermittent.

Subsidiary Hypothesis 1.6

Sites at which waste disposal groups can locate treatment plant or tips are few and far between.

Subsidiary Hypothesis 1.7

A high degree of uncertainty surrounds estimates of costs and also forecasts of waste amounts.

Subsidiary Hypothesis 1.8

Although sources of uncertainty can be identified in both cost estimates and waste forecasts, they are in fact ignored by managers and analysts.

b) Impact of the Separation of Collection and Disposal

Major Hypothesis 2

The separation of collection and disposal has established barriers which make it difficult to operate a rational analytical process. That is to say disposal cannot operate as a separate system from collection and that necessary forms of cooperation between collection and disposal authorities have not been established.

Subsidiary Hypothesis 2.1

There is no evidence of economies of scale, either engineering or otherwise, in waste disposal operations.

Subsidiary Hypothesis 2.2

There is evidence of diseconomies of scale, managerial or otherwise.

Subsidiary Hypothesis 2.3

The need to recognise the response of collection costs to disposal decisions is being coped with by means of arbitrary rules of thumb.

Subsidiary Hypothesis 2.4

Collection costs are sticky in a downwards direction in response to disposal decisions.

c) Issues of Democracy

Major Hypothesis 3

The analytical process in use does not enhance the democratic nature of local government. That is to say there is no councillor involvement and only discriminatory access for interest groups.

5.4 An Additional Hypothesis

a) The Continuing Debate about Local Authority Structure

The reform of local government structure which took place in 1974 is unlikely to be the last word on the matter. Each of the major political parties has continued to toy with the idea of further reform. One issue which is frequently discussed is the possibility that local government in large urban areas needs a different structure to that which is most suitable for the rural areas of the country. Therefore it seems worthwhile to examine the question of whether waste management problems and proposed solutions differ between different types of local authority.

Again, to try to prevent the issue being pre-judged, two alternative hypotheses are presented. The allocation of one hypothesis to the orthodox set and the other to the alternative set is relatively arbitrary. The assignment of the hypothesis that different types of authority do face different situations to the orthodox set occurs primarily because the proposed solution of the problem by further structural change is typical of the orthodox approach.

The addition to the orthodox hypothesis set is therefore:

Major Hypothesis 4

The metropolitan authorities, the London authorities and the shire authorities (in both upper and lower tiers) face different problems in the waste management field and have responded with different analytical processes.

The addition to the alternative hypothesis set is:

Major Hypothesis 4

All upper tier authorities face similar problems in the waste disposal area and have made similar responses, and the same is true of all lower level authorities.

6.0 SURVEY EVIDENCE

6.1 Introduction

a) Purpose of the Chapter

During the summer of 1977 each English county and each English district was sent a questionnaire dealing with waste management issues. This survey activity, together with follow-up telephone calls and visits, generated the data set discussed in this chapter.

The chapter has three aims, to describe the activities which generated the data set, to describe the data set, and finally to offer a statistical analysis of the data. The various parts of the questionnaires are linked to the hypothesis sets which have been developed to establish the relevance of the analysis. However the linking of analysis and hypotheses will be postponed. A complete treatment will be provided in Chapter 10, when all sources of data are brought to bear on the hypotheses.

b) Background to the Survey

The original survey was carried out during the summer of 1977[1]. Two questionnaires were prepared (see Appendix 1), one designed for use by disposal authorities, the other designed for use by collection authorities. The disposal questionnaire was dispatched to all English counties and the GLC. The collection questionnaire was dispatched to all English districts and to the London boroughs. By the end of

September it became apparent that while the response rate to the disposal questionnaire had been highly satisfactory, the corresponding figure for the collection questionnaire left much to be desired. Therefore during the autumn of 1977 a follow up exercise was instituted to discover the reason for the low response by the collection authorities. A similar, though less substantial exercise, was also aimed at the disposal authorities. A by-product of these two activities was a second batch of questionnaire returns.

During 1978 and 1979 the questionnaire data was coded and analysed. Several ambiguous/unusual responses were identified, and local authorities were again contacted to clarify issues. Recoding of data took place on the basis of these contacts. The resulting revised data set is the one which is analysed here.

6.2 Survey Response Rates

a) County Response

46 disposal questionnaires were dispatched. By the end of September, 27 had been returned. A further questionnaire was returned shortly after that, giving a total of 28 cases available for analysis. This response rate of 60.8% compares favourably with many surveys reported in the management science literature. The total of 28 consisted of 5 metropolitan counties (out of a possible total of 6) and 23 shire counties.

Apart from generating the one additional response, the telephone follow up to the survey generated four written explanations for non-response. Two cited shortage of resources and another indicated that there was a policy of non-response to unofficial questionnaires. The final non-respondent argued that the questionnaire was superficial and indicated that an in-depth study of his and other authorities should be pursued instead. Unfortunately when it was indicated that the offer to carry out an in-depth study would be accepted at a later stage of the research (Chapter 7), it was withdrawn!

b) District Response

365 collection questionnaires were dispatched. By the end of September 132 had been returned. This 36% response rate, together with the prevalence of a state of partial completion among the returned questionnaires, indicated that something had been amiss with the

original questionnaire. In order to investigate the reasons for non-response or only partial response, a sub-sample of districts was contacted by telephone. This activity generated an extra 10 responses, giving a response rate of 39%, and 32 written reasons for non-response. Of these, 5 simply indicated that there was a policy of non-response to unofficial questionnaires. A further 7 indicated that the bulk of information required was unavailable. The remaining 20 cited resource shortages.

One possible reason for this relative failure of the district questionnaire seems to be that the data requested was not available. The questionnaire presumed the existence of an established data collection activity and asked about the types of data collected. However it is possible that districts were not collecting data and therefore could not respond to the questions asked. The reasons given for non-response support this view.

6.3 Survey Questions and Hypotheses

a) The survey exercise was intended to provide an overview of the management of waste. Therefore the hypotheses currently under investigation do not match the survey questions as neatly as might be wished. However the survey does provide relevant information.

b) Disposal Question 1

"For how long can your existing disposal (landfill) sites handle anticipated future waste?"

The ability of a disposal officer to answer this at all has implications for the existence of forecasting procedures for waste amounts. At very least, the possibility of a subjective forecasting procedure is implied. The specific answers given are also important for major hypothesis 2 which deals with the ability of collection and disposal to operate as separate activities. If anticipated landfill life is short, either new sites must be developed or intermediate treatment must be introduced. In either case, collection vehicles are likely to face a changed destination, and district costs may therefore change. Such a situation will test the ability of the county/district system to cope. If existing landfill sites provide adequate capacity for the foreseeable future, then counties and districts may operate independently in a quite satisfactory fashion, simply because a stable situation does not highlight any problems.

c) Disposal Question 2

The question attempted to identify the difficulties facing counties in extending existing tip sites or in opening up new ones. Respondents were offered a list of four problems, a financial constraint, planning permission requirements, absence of suitable holes, and the presence of an environmentably concerned lobby. They were asked to specify an additional constraint if the offered list was inadequate, and then to rank the constraints.

This question specifically relates to subsidiary hypothesis 1.6, which deals with site availability. It also has implications for the ability of counties and districts to operate separately. If, according to the response to question 1, counties have a need to open new sites, then any constraints on their choice may make it difficult to locate new sites in positions convenient for district operations.

d) Disposal Questions 3, 4, 5, 6, 10

These questions relate to information collection activities and in particular to the information received by counties from districts. The questions directly relate to subsidiary hypothesis 1.5, which deals with the presence or absence of a regular and relevant data collection activity.

Question 3 attempts to identify the types of information flowing from districts or counties. It offers a menu of parameters which the respondants can check or ignore. The elements in the menu have all

been assumed to be available in some part of the management science literature already discussed. Question 4 asks whether explanatory comment accompanies any data which pass from district to county.

Questions 5 and 6 attempt to deal with the value of the information flow. Respondants are asked whether the data is adequate for decision-making and what, if any, additional information is needed.

Question 10 asks whether any waste analysis is carried out by the county. The idea behind the question is to see if counties add to data flows by their own efforts.

e) Disposal Questions 7, 8, 9

These three questions deal with the issue of contact between county and district officers. Question 7 asks about the form and frequency of contacts, while question 8 asks whether a different form and/or frequency would be preferred. Only if question 8 is answered in the afirmative does question 9 come into consideration. The questions relate to major hypothesis 2, which asks whether necessary forms of cooperation have been established between counties and districts.

f) Disposal Questions 11, 12, 13, 14, 15

This block of questions deals with the use of management science techniques by counties. Question 11 offers a menu of techniques and asks counties to check those which have been used. Question 13 checks whether such techniques are in current use. These are the key

questions in this block. Of the other questions, 12 and 14 explore reasons for use of management science techniques and question 15 checks whether there is an intention to use such techniques among counties not currently using them.

The block of questions relates to subsidiary hypothesis 1.2, which deals with the use being made of modern management science techniques.

g) Collection Question 1

This question attempted to explore the difficulties hindering improvement of collection services by districts. A list of difficulties is presented and respondants are asked to rank these difficulties in order of importance.

The question relates to major hypothesis 2, which questions whether disposal and collection can operate independently or not, in that one element in the problem list is the distance collection vehicles may have to travel to disposal sites. The question also has implications for subsidiary hypothesis 2.4, which deals with the freedom of districts to adjust their collection procedures.

h) Collection Questions 2, 3, 4, 5

These questions deal with issues of data availability. Specific historical rates and forecasts are requested for percentage changes in waste amounts and collection costs. A more general question about types of information collected is also asked. The pattern of data

types which respondents are invited to check is the same as that which featured on the disposal questionnaire in the question dealing with types of data being received from districts.

The questions relate to subsidiary hypotheses 1.1 and 1.5. These deal with the existence of forecasting procedures and data collection procedures.

i) Collection Questions 6, 7, 8, 9, 10, 11

These questions deal with passage of information to the counties, and to the form and frequency of liaison between counties and districts. The questions relate to main hypothesis 2, which discusses the existence of necessary forms of cooperation between districts and counties.

6.4 Survey Analysis

a) Disposal Question 1

There were 28 usable responses to this question. No comments, added to the questionnaire documents, or returned with them, suggested that the required forecast was either unavailable or impossible to produce. No indication was given by any respondent as to how the forecast was produced, or as to whether it was a best or worst possible case, or something in between.

The bar chart (Figure 6.4.1) shows the absolute frequency with which each anticipated tip life was selected by respondents. 42.9% of respondents indicated that on a county-wide basis tip capacity was six years or more. However, margin comment and follow-up discussions with respondents indicated that the reported county-wide capacity figures were averages hiding large variation in tip capacity within a county. On the basis of this additional information respondents were classified as needing to open a new disposal facility within five years, or not. The bottom margin totals of the contingency table (Table 6.4.1) show that 22 respondants (78.6%) saw themselves as likely to have to open a new landfill site within five years, while 6 (21.4%) did not.

The right hand side margin totals in Table 6.4.1 show the number of metropolitan (5) and non-metropolitan counties (23) among the respondants. It is of interest to ask whether metropolitan and non-metropolitan authorities differed on this issue of need to open new landfill sites. Fisher's exact test allows a test of the hypothesis

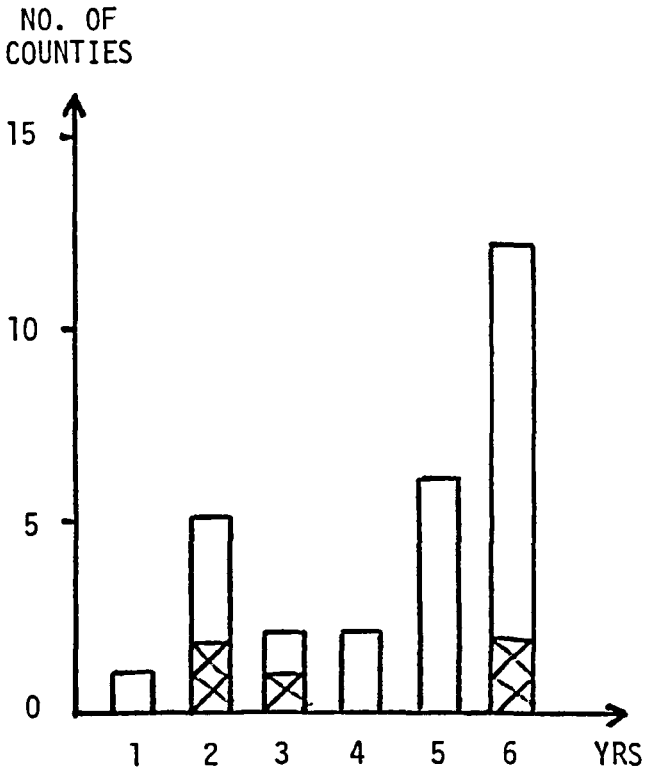


Figure 6.4.1

Anticipated Tip (Landfill) Life

	D	N.D	
SHIRE COUNTIES	18	5	23
METROPOLITAN COUNTIES	4	1	5
	22	6	28

D ∿ Decision on landfill needed within 5 years

N.D ∿ No decision on landfill needed within 5 years

TABLE 6.4.1

Landfill Capacity v. County Type

that the metropolitan and non-metropolitan counties "differ in the proportion with which they fall into the two classifications" (Siegel, 1956, p 97). The null hypothesis is that there was no difference in the proportions. The most interesting alternative is that a greater proportion of non-metropolitan counties than of metropolitan counties had no need to open new landfill sites within a five year time horizon. A rationale for this alternative hypothesis could be that metropolitan counties have more alternative uses for land and therefore are not able to develop a landbank for tipping purposes.

The exact probability of observing the particular set of frequencies in the 2 x 2 contingency table is:

$$p = \frac{(23!)(5!)(6!)(22!)}{(28!)(18!)(5!)(4!)}$$

$$= 44.7\%$$

The more extreme case of no metropolitan county being free from pressure will also have a positive probability. Therefore the observed frequencies are perfectly consistent with the null hypothesis that there is, in this case, no difference between metropolitan and non-metropolitan counties. This, at first sight surprising, result is reasonable given the heterogeneous nature of the metropolitan group. West Midlands, for example, is an urban sprawl, while South Yorkshire has large non-urbanised areas and a major extractive industry (coal mining).

In conclusion, then, counties can produce forecasts. Furthermore approximately two thirds of all counties faced the possibility of having to open new landfill sites within five years.

b) Disposal Question 2

25 complete responses were obtained to this question. However, the three incomplete responses did include some relevant information. One respondent indicated an overriding concern with the problems of obtaining planning permission. This response came from a shire county, but the concern with planning permission was shared, although to a lesser extent, by a metropolitan non-respondent. This metropolitan county also emphasised the impact of a well-developed environmental lobby. The remaining county which offered an incomplete response, another shire county, stated that the overriding problems were seen to be the activities of environmental pressure groups and the requirements of the water authority.

The 25 complete responses came from 21 shire counties and 4 metropolitan counties. Of these, 14 counties chose to make use of the option to specify a constraint in addition to those listed. Of these, 11 indicated that the requirements of the local water authority generated a significant additional constraint. The remaining 3 counties each identified a different additional constraint. These were manpower shortages (a shire county), "procedural problems" (a metropolitan county) and engineering problems (a shire county). The procedural and engineering problems were ranked as least important (rank 5) by the relevant counties. The manpower shortage was assigned

rank 2 by the particular county concerned. However further contact with this county indicated that it had proved a temporary problem only.

In the light of the importance assigned to the activities of the water authorities, this has been identified as a separate constraint in the following analysis. Figure 6.4.2 therefore presents five bar charts showing the frequency with which constraints were mentioned and the ranks assigned to them. The crossed blocks in the bar charts show which responses came from the metropolitan counties. Table 6.4.2 presents a numerical summary of this information.

The importance assigned to the requirements of the water authorities is an interesting feature of the data. 44% of the sample mentioned it, and of those that did mention it 91% ranked it as the most important constraint. If the constraint was present at all it was clearly critical. Again, using Fisher's exact test, the hypothesis that this particular constraint was equally important to metropolitan and shire counties can be tested. The 2 x 2 contingency table which is the basis of the test is shown in Table 6.4.3. The exact probability of observing the given frequencies is:

$$p = \frac{(21!)(4!)(14!)11!)}{(25!)(10!)(11!)(4!)}$$

$$= 0.079$$

So the hypothesis of no difference can be rejected at the 10% probability level in this case.

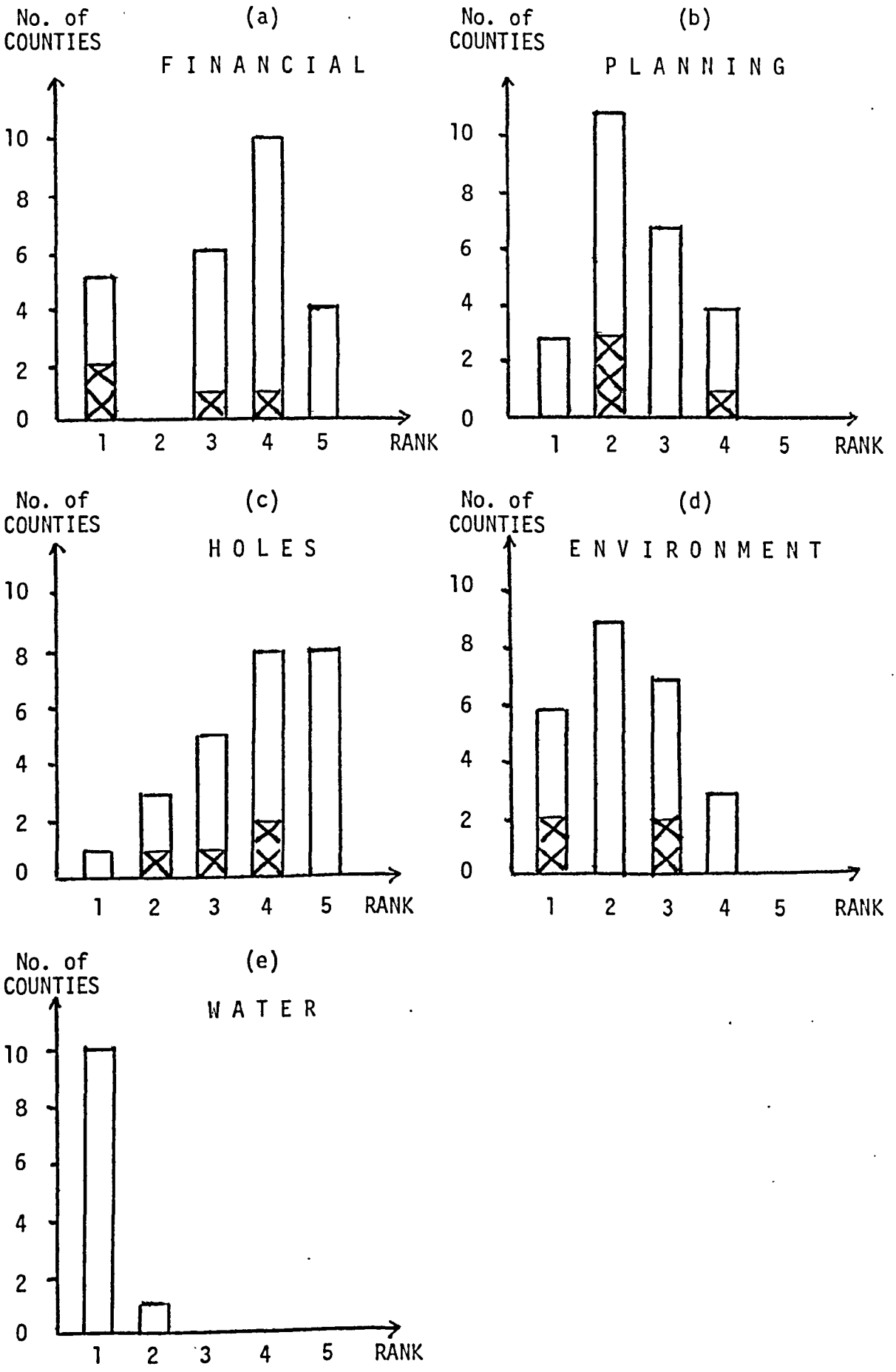


Figure: 6.4.2

Constraints on Developing Landfill Sites

	NUMBER OF RESPONSES			MEAN RANKS			MEDIAN RANKS		
	TOTAL	MET	SHIRE	TOTAL	MET	SHIRE	TOTAL	MET	SHIRE
FINANCIAL	25	4	21	3.3	2.3	3.5	4	2	4
PLANNING	25	4	21	2.5	2.5	2.5	2	3	2
HOLES	25	4	21	3.8	3.3	3.9	4	3.5	4
ENVIRONMENT	25	4	21	2.3	2	2.3	2	2	2
WATER	11	0	11	3.8*	6*	3.4*	6*	6*	2*

* Non responses assigned rank 6

TABLE: 6.4.2

Constraints on Developing Landfill Sites

TABLE: 6.4.3

Water Authority Constraint v County Type

	Constraint Absent	Constraint Present	
Shire C	10	11	21
Metropolitan C	4	0	4
	14	11	25

Having examined the response to the invitation to specify an additional constraint attention can now be turned to the constraints which were specifically identified in the questionnaire. To facilitate analysis the data have been recoded to exclude the "other constraint" category. Thus, for the 25 cases available, the four specified constraints have been assigned numbers 1 to 4. The assignment was carried out so that the ordering of the constraints in each response was maintained. The revised responses are given in the bar charts in Figure 6.4.3.

The most obvious effect of this recoding on the appearance of the bar charts is on the graph dealing with the environmental constraint. Also, after recoding there are significant differences between the patterns of rankings for different constraints. For example the bar chart dealing with the environmental constraint now differs dramatically from that dealing with the lack of holes. This appearance of difference can be tested statistically using Friedman's "two way analysis of variance by ranks" test (Seigel, 1956, p.166). The thrust of the test can perhaps best be seen by applying it to the subset of responses coming from the metropolitan counties. These responses are shown in Table 6.4.4 below:

COUNTY	FINANCIAL	PLANNING	HOLES	ENV.
(C17)	1	4	2	3
(C36)	1	2	4	3
(C42)	3	2	4	1
(C44)	4	2	3	1
Σ	9	10	13	8

TABLE 6.4.4

Metropolitan County Rankings

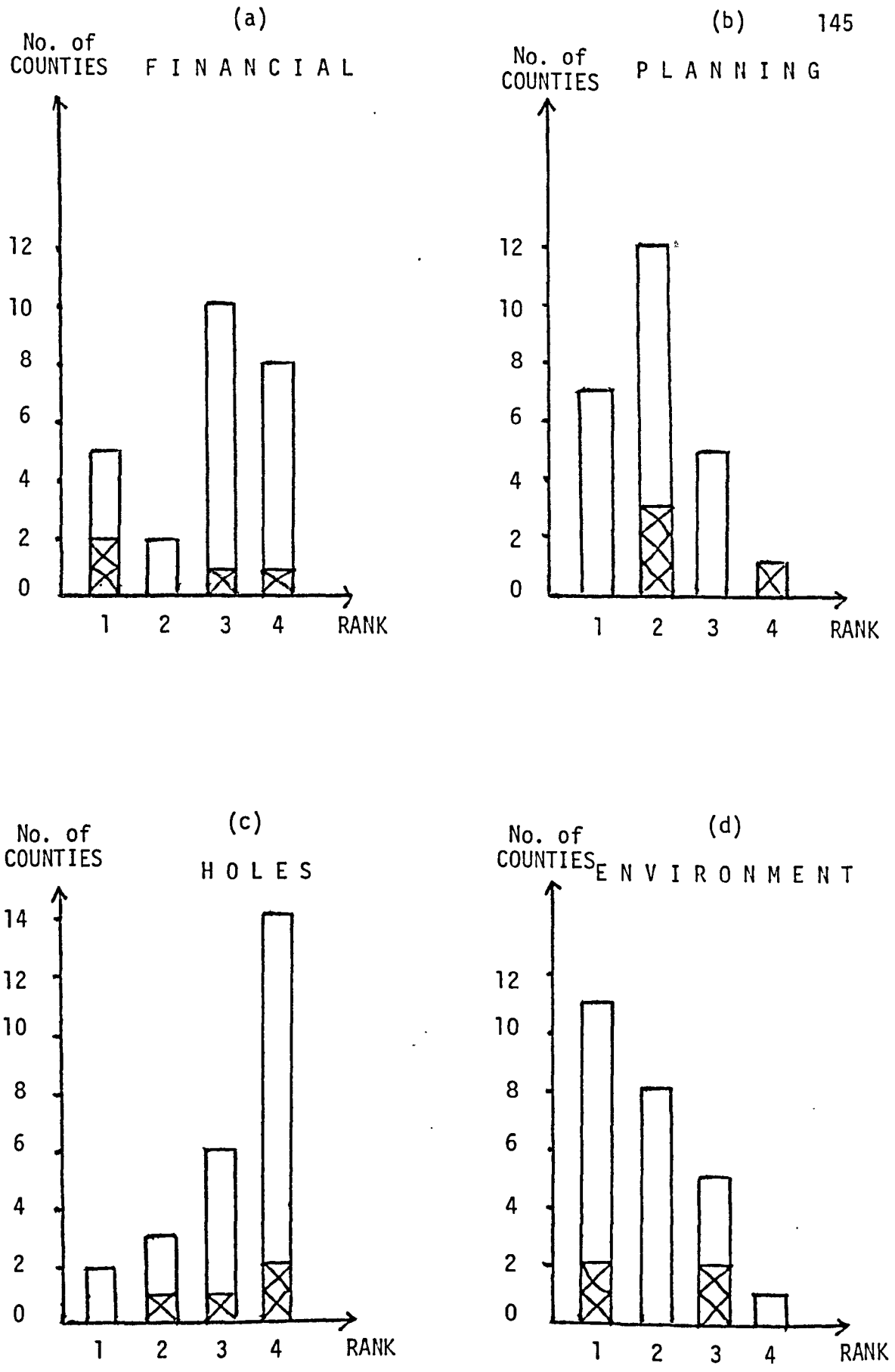


Figure: 6.4.3

Constraints on Developing Landfill Sites (exc. Water)

Essentially the aim is to discover whether the four constraints are seen as equally important by the metropolitan counties or whether there are differences between them. If the ranks assigned to each constraint in turn are summed, four totals result. If the null hypothesis of no difference in severity is true, then there should be no systematic tendency for any one constraint to be given low (or high) ranks by all subjects. Thus the four rank totals should be similar. On the other hand, if the null hypothesis is false, the totals should differ.

Friedman's test statistic is given by:

$$\chi_r^2 = \left\{ \left[\frac{12}{nk(k+1)} \right] \Sigma(R_j^2) \right\} - 3n(k+1)$$

where n is the number of counties

k is the number of constraints

R_j is the sum of ranks for the jth constraint.

For the metropolitan county data $\chi_r^2 = 2.1$. Using published statistical tables the probability of this result can easily be found. In this case there is approximately a 65% chance that a result of 2.1 or higher could occur if the null hypothesis is true. Therefore the hypothesis of no difference in perceived severity cannot be rejected for the metropolitan counties.

χ_r^2 can be translated into a measure of agreement between the metropolitan counties, Kendall's Coefficient of Concordance - a type

of correlation coefficient (Leach 1979, p.219). The translation is achieved by:

$$W = \frac{X_r^2}{n(k - 1)}$$

In this case W = 0.17. W is bounded below by zero and above by one. Thus, because the hypothesis of no difference in perceived severity cannot be rejected for the metropolitan counties, a 'typical' ranking is difficult to discern.

Friedman's X_r^2 can also be calculated for the shire counties. In this case X_r^2 is 17.83. The null hypothesis of no difference in perceived severity is clearly rejected. The coefficient of concordance for the shire counties is however only 0.28. Clearly differences in perceived severity exist, but there remains disagreement between counties about rankings.

The analysis appears to support the following conclusions. The a priori view of the type of constraints likely to affect county operations is supported by and large. However the activities of the water authorities clearly deserve further emphasis. Given that the analysis of the response to question 1 indicated a shortfall in landfill capacity, there is now evidence that constraints exist on possible site locations. It is likely therefore that counties and districts will not be able to exist in isolation but will have to interact.

There is evidence that constraint rankings differ between counties. For this reason a comparison between a typical shire county, ranking

and a typical metropolitan county ranking has not been attempted. However it was possible to demonstrate that shire and metropolitan counties do differ, at least with respect to the importance of the activities of water authorities. This variation in constraint rankings may have implications for the feasibility of counties adopting similar analytical processes.

c) Disposal Questions 3, 4, 5, 6, 10

At first sight it appeared that these questions had been ignored by a high proportion of respondents. However, follow up discussions indicated that lack of response reflected absence of data flows rather than anything else. The original questionnaire, together with follow up contacts, therefore yielded usable responses.

Taking cost data first, the response to question 3 indicated that among the responding 28 counties, only 5 (17.8%) claimed to be receiving cost data from the districts. Only 1 claimed to be receiving it on a regular basis. Typically the only data made available was annual total cost. The event which led to data being provided, when provision was irregular, seemed to be discussion of compensation payments. Of the 12 counties which identified an additional information requirement in question 6, 10 identified a need for district cost data. Two of these however indicated that such data was unlikely to become available because of a conflict of interests between counties and districts. A further county indicated that although additional data would be valuable, the cost of obtaining it might be prohibitive.

Rather more waste quantity data appeared to be available. 16 counties (57%) indicated that they were receiving waste quantity data. However once again provision of data seemed to be on an irregular basis; 13 of the 16 counties receiving data (81.3%) indicated that this was the case. Total weight of waste data per time period seemed to be the information most frequently provided. The contingency table shown in Table 6.4.5 shows the respondents allocated along the dimensions, waste data receiving/non-receiving and metropolitan/shire. There is a 26% chance of getting this result or one more extreme according to Fisher's exact test:

	WDR	WDNR	
Shire	12	11	23
Metropolitan	4	1	5
	16	12	28

WDR ∿ Waste data receiving

WDNR ∿ Waste data non-receiving

TABLE 6.4.5

Data Receiving v County Type

The requirement for additional data on waste amounts did not feature significantly in the responses to question 6. This may be due to the fact that the response to question 10 indicated that several counties were collecting waste data themselves. 18 counties (64.2%)

indicated that they carried out/had carried out a waste analysis exercise. This response, coupled with comments (written in on questionnaires, and offered during follow up interviews), which indicated that certain counties were collecting waste amount data, implies that only 4 counties (14.3%) had no waste quantity data, and only 3 counties (10.7%) claimed to receive no waste related data at all.

However incomplete the data sets available to counties are (compared say to the pattern implied by question 3) there appeared to be evidence that a significant proportion of counties had waste quantity related data and that in many cases districts were a data source. Districts are of course the only source for collection cost data. Of the 16 counties receiving information from the districts, only 8 were receiving any kind of explanatory comment with it. This, it would seem, has to diminish the value of the information received.

It remains to discuss the response to question 5. This dealt with the adequacy of the data received for decision making purposes. 25 responses were received to this question. In the 2 x 2 contingency table shown as Table 6.4.6, these responses are classified as adequate/inadequate for decision making purposes against receiving information from districts/not receiving information from districts.

This table emphasises a surprising fact: zero information was classified as adequate for decision making by 4 counties, 44% of those not receiving information. Using Fisher's Exact Test, the hypothesis that perception of adequacy of data was not affected by whether or not data were actually being received can be tested. This hypothesis cannot be rejected!

TABLE: 6.4.6

Adequacy of Data v. Receiving Data

	ADEQUATE	INADEQUATE	
RECEIVING	9	7	16
NOT RECEIVING	4	5	9
	13	12	25

d) Disposal Questions 7, 8, 9

27 usable responses were received to question 7. All responding counties indicated that they had some contact with districts. Of these 27, 14 (52%) indicated that both formal and informal contacts took place, 11 (41%) indicated that all contacts were on an informal basis, and 2 (7%) indicated that all contact was formal. During follow up contacts an attempt was made to ensure that contacts designated as formal involved persons meeting in their official capacity, in a forum designated as dealing with waste disposal and collection issues. Contacts, however regular, that could be terminated by one party without reference to anyone else were designated informal. The percentages given reflect these definitions.

Of the 16 counties claiming that formal contact took place, 1 indicated that there were monthly meetings, 10 specified quarterly meetings, 1 a semi-annual meeting and 1 an annual meeting. The 3 remaining counties indicated that the formal contacts were at irregular intervals and infrequent. Of the 25 counties claiming that informal contacts took place, 5 indicated that there were contacts at

least every week, 2 indicated that contacts took place at least every quarter, and the remainder indicated that contacts took place as and when necessary, but were infrequent.

There is some indication that metropolitan counties were more likely to have formal contacts with districts than shire counties, but the evidence is not conclusive. Using Fisher's exact test the probability of getting the result shown in Table 6.4.7, or one more extreme is 30% given the null hypothesis of no difference.

	FORMAL CONTACT	NO FORMAL CONTACT	
SHIRE	12	10	22
METROPOLITANS	4	1	5
	16	11	27

TABLE: 6.4.7

Type of District/County Contact v. County Type

Only 2 counties expressed themselves dissatisfied with the form and extent of their contacts with districts, and only 1 chose to specify a preferred alternative. This particular response indicated dissatisfaction with the county/district split of responsibility.

e) Disposal Questions 11, 12, 13, 14, 15

27 usable replies were received to question 11. The number of counties claiming to have applied particular techniques is shown in Table 6.4.8:

TECHNIQUE	NUMBER USING	%
Simulation	7	6
Linear Programming	11	41
D.C.F.	12	44
Other	7	26
Any	17	63

TABLE: .6.4.8

Patterns of Use of Modern Management Techniques

63% of respondents claimed to be using/have used some management science technique. Discounted cash flow was most popular, with 44% of respondants claiming use, while L.P. came a close second with 41%. According to the response to question 13, 12 counties were currently using one technique or another. Of the 10 counties who claimed no past or present use of the techniques, 2 indicated that there were no plans to introduce them, 2 claimed that there were definite plans to introduce them, and 6 claimed to be undecided.

At first site this seems an apparently rosy picture in that 63% of counties have experience of using management science techniques.

However certain caveats need to be entered. Firstly, in two counties, the work referred to was being carried out by the author. Secondly, the comments, included on the questionnaires, or gathered by follow-up contacts, cast some doubt on the way the techniques were being applied. Two counties claimed to have used L.P. in capital expenditure decisions and yet stated they were not using discounted cash flow analysis. This suggests that L.P. was being used to minimise operating costs, but that no comparison of current capital expenditure with future operating cost savings was made. This is only a partial analysis, but possibly the need to make the capital investment was generated by a level of service criterion, and analysis centred on comparing disposal alternatives with similar capital costs(2).

The split of using and non-using counties between the shires and the metropolitans is shown in Table 6.4.9:

	TECHNIQUE USERS	NOT TECHNIQUE USERS	
SHIRE	12	10	22
METROPOLITANS	5	0	5
	17	10	27

TABLE: 6.4.9

Use of Management Science Techniques v. County Type

This arrangement has only a 7.6% chance of occurring if there is no difference between shires and counties on this issue.

In Table 6.4.10 the answers to question 11, which basically asked "are you using management science techniques?" have been grouped in relation to the answers given to question 5 which relates to satisfaction/dissatisfaction with data flows from the districts.

	TECHNIQUE USERS	NOT TECHNIQUE USERS	
DATA O.K.	5	7	12
NOT O.K.	11	1	12
	16	8	24

TABLE: 6.4.10

Data Adequacy v. Use of Management Science Techniques

There appears at first sight to be a tendency for counties which were not using management science techniques to be satisfied with data flows from districts and for those using management science techniques to be dissatisfied. As can be seen from the table only 31% of technique users were satisfied compared to 88% of non-technique users. Whether the difference between these figures is significant or not can be checked by using Fisher's exact test once again. There is less than a 2½% chance of the pattern of data shown in Table 6.4.10, or a pattern more extreme appearing if there was no difference between technique users and non-technique users in the matter.

This result is interesting. Earlier analysis indicated that satisfaction or dissatisfaction with data supplied did not depend on the presence of data. It is now suggested that it depends on whether the county had a management style which involved data use, that is to say a style which involved the use of management science techniques.

f) Collection Question 1

This question generated 139 usable responses, 8 from London boroughs, 19 from metropolitan districts and the remainder from rural districts. Some districts gave some constraints equal weight. Where this happened the data were recoded and equally serious constraints were assigned the appropriate midrank figure (Leach, 1979, p.67).

The questionnaire allowed districts to specify and rank a single constraint in addition to those listed in the question. However few districts chose to do so. Those that did tended to duplicate already listed constraints. Therefore with recoding it proved possible to eliminate the 'other constraint' category. In the analysis that follows then, five constraints are dealt with: a financial constraint, an increase in waste constraint, a manpower shortage constraint, a distance from disposal location constraint, and a labour problem constraint. As with the disposal data a low numerical rank indicates an important constraint.

Figure 6.4.4 summarises the response to this question in bar chart form. The frequency with which the financial constraint is ranked as most important is easily seen. In fact 77% of respondents identified this

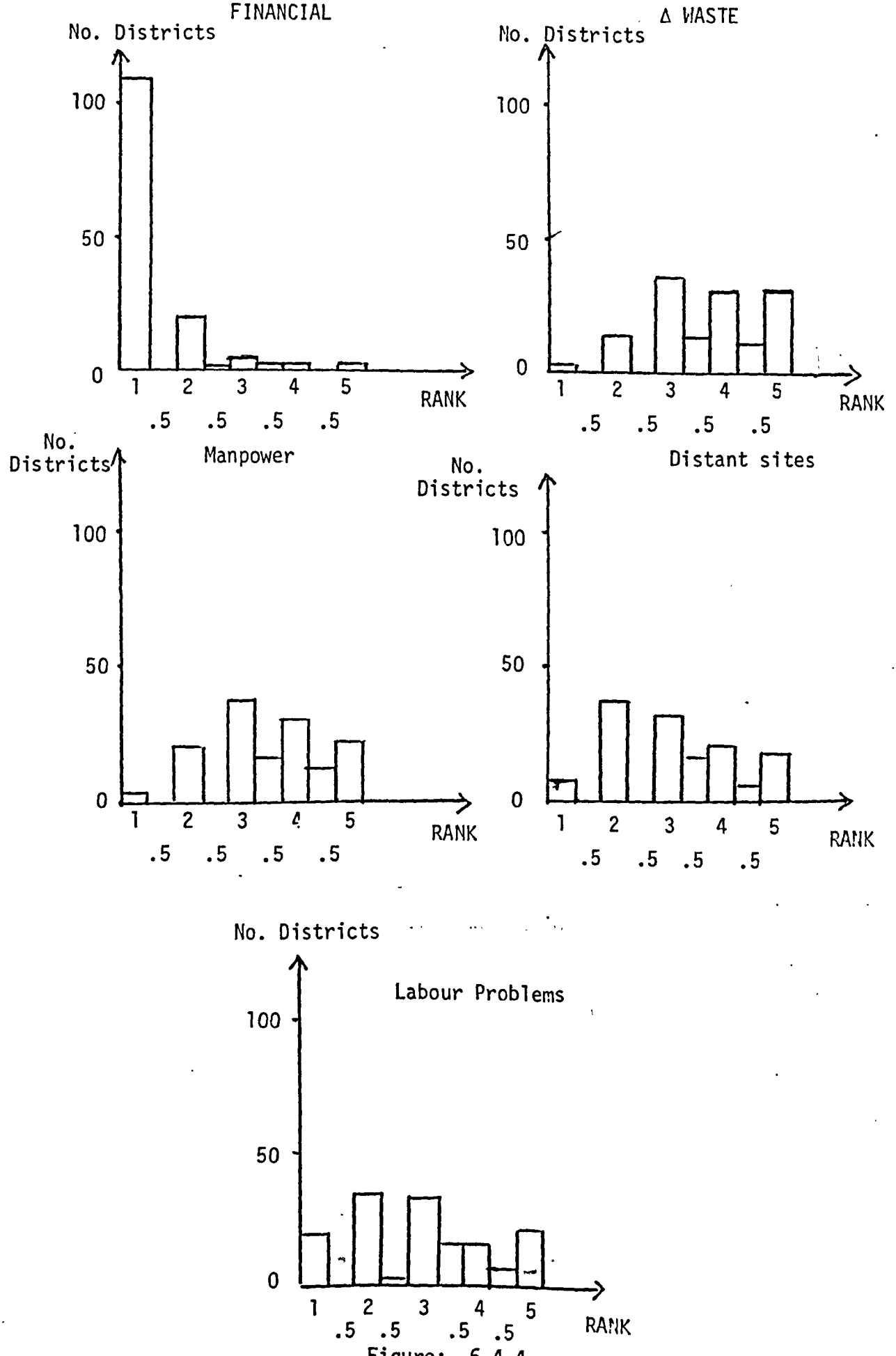


Figure: 6.4.4

Constraints on Improving Collection Activities

as of first importance. No other constraint came close to challenging the financial constraint's importance. The relative importance of the remaining constraints can best be seen by examining the mean and median ranks shown in Table 6.4.11. The set of all responses indicates that after the financial constraint, labour problems and distance from sites were the most severely felt constraints. After them come the labour shortage constraint and then the increase in the amount of waste. If the responses are split into those coming from rural districts, metropolitan districts and London boroughs, it can be seen that a similar ordering of the constraints appears for each individual group. What differences do exist are as follows:

(1) For the metropolitan group the greater importance of the labour problem constraint as opposed to the distance from sites constraint seems clearer.

(2) For the London boroughs, the labour problem constraint is seen as being equally as important as the financial constraint.

The pattern of responses offered by the districts was explored in a series of follow up visits. The overriding importance of the financial constraint was seen as due to overall central government policy, rather than anything specific to waste management. However the importance of the labour problem constraint was seen as something specific to waste management. Several managers argued that the unwillingness to change work patterns and work practices on the part of the labour force was far stronger in the waste collection area

	TOTAL		METS		LBS		SH	
	MEA	MED	MEA	MED	MEA	MED	MEA	MED
FINANCIAL	1.35	1	1.5	1	1.94	2	1.28	1
Δ WASTE	3.7	4	3.8	4	4.1	5	3.63	3.5
SHORTAGE	3.53	3.5	3.3	3	3.9	3.75	3.54	3.5
SITES	3.16	3	3.3	3	3.1	3.25	3.14	3
LABOUR	2.99	3	2.6	2	1.94	2	3.13	3

TABLE: 6.4.11

Constraints on Improving Collection Activities

than elsewhere in local government. Whether this relative ranking of waste collection and other local government activities is valid has not been explored. In the present context, the force of the comment is that it was restrictions on work practices rather than, say, lack of training, which underpinned the high ranking generally assigned to the labour force constraint.

g) Collection Questions 2, 3, 4, 5

There were 142 usable responses to question 2. 'Data unavailable' responses were classed as usable. This asked districts to indicate % changes in weight and volume of waste in the immediate past, and to produce forecasts of % changes in the immediate future. Only 54 districts (38%) found it possible to provide even a partial answer. Of these 54, 7 provided forecast data only, 3 historical data only, and 44 both historical data and forecasts.

The willingness of 7 districts to provide forecasts while not being able to report historical data may seem strange at first sight. Follow up contacts indicated that respondants were basing forecasts on intuitively perceived correlations with variables for which forecasts were available, e.g. new dwellings. Others among the total of 51 districts providing forecasts may have followed a similar approach. However many others appear to have extrapolated past data in a simplistic fashion.

The likelihood of availability of historical data on waste quantity did appear to vary between types of district. Table 6.4.12 shows data availability by type of district.

	DATA AVAILABLE	DATA UNAVAILABLE	
SHIRE	34	79	113
METROPOLITANS	6	14	20
L.B.s	7	2	9
	47	95	142

TABLE: 6.4.12

Waste Quantity Data Availability

Perhaps surprisingly London boroughs and metropolitan districts appeared to differ in terms of proportion of respondents with data available. This difference is confirmed by the application of Fisher's Exact Test. The exact probability of the achieved results or some more extreme version occurring is .0265%. The difference between London boroughs and metropolitans is clearly significant.

There were again 142 usable responses to question 3. This asked districts to indicate % changes in collection costs in the immediate past and to produce forecasts of % changes in the immediate future. 98 districts (69%) found it possible to provide either actual data or forecasts or both. 88 provided both types of data, 6 provided forecasts only, and 4 actual data only. Of the 92 districts providing actual data, several indicated that pre-1974 actuals were not available, or were not an appropriate basis for calculating a percentage change. District boundary changes due to reorganisation were cited as the reason for this.

The distribution of districts capable of providing actual data by type of district is shown in Table 6.4.13:

	DATA AVAILABLE	DATA UNAVAILABLE	
SHIRE	74	39	113
METROPOLITANS	14	6	20
L.B.s	4	5	9
	92	50	142

TABLE: 6.4.13

Historical Data Availability

$\chi^2 = 1.797$

df = 2

There is again some suggestion that the London boroughs differ from the rest of the country in data availability. The hypothesis of no difference in proportion of different types of district having data available can be tested using the χ^2 test (Siegel, 1956, p 104). In this case ($\chi^2 = 1.797$ with 2 d.f.) the difference is not statistically significant.

Question 4 generated an extremely thin response. While several districts indicated that data were being collected, it was clear from the nature of their response that the pattern of information specified in question 4 did not provide a useful framework in which district

activities could be reported. Available data did not seem to extend beyond annual totals. Even simple ratios like cost per ton did not seem to be routinely recorded. Because of the quality of the response to this question, follow up visits and contacts dealt with this issue specifically. The overall impression gained was that there was an almost total lack of management accounting activity. The emphasis was on recording expenditures and revenues rather than on control and decision making. 96 districts claimed to be collecting some of the information. Of these 52 (54%) claimed that it was available on an annual basis only. A further 35 claimed that data was collected regularly for time periods shorter than a year.

Question 5 was again answered by relatively few respondents. These responses typically identified the county as responsible for recording waste amounts or the treasurer's department as responsible for collection cost data.

h) Collection Questions 6, 7, 8, 9, 10, 11

Only questions 6 and 9 generated other than a spasmodic response. Question 6 deals with information being sent from districts to counties, while question 9 deals with liaison between these bodies.

141 responses were obtained to question 6. 100 responses (71%) indicated that no information was provided to counties. 38 districts claimed to be sending refuse analysis data to counties and 33 claimed to be sending collection cost data. The pattern of data provision by type of district is shown in Table 6.4.14.

	COST	REFUSE	BOTH	NONE	
METROP.	1	1	6	12	20
LONDON BOROUGH	0	1	5	3	9
SHIRE	2	6	19	85	112
	3	8	30	100	141

TABLE 6.4.14

Provision of Data to Counties

Again there is some suggestion that districts which provide no information are more likely to be found in the shire counties than elsewhere. This hypothesis can be tested using a χ^2 test. The test ($\chi^2 = 8.47$ with 2 d.f.) shows that the hypothesis, that shires, metropolitans and London boroughs do not differ in terms of likelihood of providing information, can be rejected at the 2% probability level.

It may be recalled that disposal question 3 attempted to identify if county waste disposal groups were receiving data from districts. The types of information dealt with were related to waste quantities and collection costs. The data just analysed deals with information being sent by districts to counties. In this case also collection cost data are specifically identified. Therefore the possibility of comparing county and district responses arises. Only a subset of the available data is relevant to this comparison. Many district responses are

irrelevant because the relevant county did not respond. One county response is irrelevant because no district within that county responded. Furthermore in no case did all districts within a county respond. Therefore a county's claim to have been receiving collection cost data cannot be called into question simply because no responding district seemed to be sending data. It may be that districts which did not respond to the questionnaire were providing data. The issue under debate then is the following: are there any county waste disposal groups which claimed to receive no collection cost information, when districts within the county claimed to be sending such information?

23 counties claimed to be receiving no collection cost data and in 22 cases the possibility of refuting this claim exists. In fact in the case of 13 counties, the claim that collection cost information was not available is contradicted by at least one district within the county boundary! What might be at the back of this disagreement? One possibility is that the way in which the data was presented by districts caused county officers to discount it. Several districts stated in margin comments on questionnaires that data was only provided to counties as the basis of a claim for reimbursement. Perhaps counties regarded such data as suspect.

Question 9 on the district questionnaire deals with the form of contacts between counties and districts. 119 districts indicated that there was some form of contact between themselves and the county authority. Only 18 indicated that there was no contact with the relevant county. Informal contact was the norm, although 44 shire districts (41%) and 8 metropolitan districts (40%) claimed to have

formal meetings. No London borough claimed to have formal contact with the GLC. The preceding analysis seems to indicate that little cooperation exists between districts and counties. Little data is passed on to counties by districts and when it is passed on, it appears often to go unnoticed. Further, there is confirmation for the county response that contacts tend to be informal. A key question remaining unanswered is what is the content of these informal contacts.

NOTES

1. The author wishes to acknowledge the substantial help given by John Lee and Tom Watson during the early part of the survey exercise. Using funds provided by the SSRC I funded John Lee's MSc summer project. His brief was to assist me in the design and distribution of the two questionnaires and to code up and analyse the resulting response. I identified the issues; he produced the questionnaires. His analysis can be found in Lee (1977). Tom Watson acted as his supervisor during the project.

   It should be pointed out that the data analysed here are based on a data set which differs from that available to John Lee. Firstly various coding errors have been removed. Secondly the number of cases included is larger and thirdly the data has been recoded in the light of interviews with respondents.

2. As in the Blackpool case, see Chapter 8.

7.0 INTERVIEW EVIDENCE

7.1 Introduction

a) Background to the Interviews

During 1979 and 1980 the author was provided with SSRC finance to allow an investigation into the types of planning activity being carried out by waste management groups in the English counties. Several counties were contacted and asked if they would allow staff to be interviewed about planning processes. In the event, seven counties took part in the study. Time constraints limited the number of counties examined to seven.

Participating counties were asked to identify an officer who was closely involved with whatever waste planning activity was going on. This officer was interviewed by the author and Mrs Matina Mitchell, a researcher financed by the SSRC grant[1]. This initial interview served to identify specific additional questions to be asked, relevant documents to be examined, and additional personnel to be contacted. Further visits to the counties then took place.

At the end of 1980, participating counties were presented with a paper describing the kinds of planning activities which appeared to be going on (Berry and Mitchell, 1980). Specific counties were also asked to complete a short questionnaire after reading that paper (see Appendix 2). Each county was then

contacted once again so that the researchers could check their interpretation of what was going on.

b) Confidentiality

Officers and councillors expressed themselves very frankly during discussions with the researchers. On occasion the request was made that a comment should not be directly attributable to an individual. At the end of the research project several participants asked that they and their counties should not be identified by name. It was therefore decided not to identify any county or person by name in any written material based on the research project(2). In what follows, counties are identified by a single letter code. However enough information is given as background to specify the environment in which waste disposal operations were being carried out.

c) Purpose of Chapter

This chapter contains seven short case studies, one for each county. The background to the waste management problem faced is described in each case, and a description is given of the analytical process going on. The phrase "planning process" is frequently used instead of "analytical process" since that was the phrase used during interviews. However the process under examination is that described in Chapter 2, and the stages of analysis defined there are used to structure the case studies.

The case studies provide evidence relevant to both sets of hypotheses. However the linking of evidence and hypotheses will not be stressed in this chapter. This will form the basis of Chapter 10, where evidence from all data sources will be pulled together.

7.2 County 'A'(3)

a) Background

This shire county inherited six landfill sites when it took over the disposal function in 1974. All six were still in operation in 1980. In part this was due to the fact that extension to some of the existing sites had proved possible. In 1980, no site was close to full and two particularly large sites had anticipated lives of thirty years.

County officers indicated that relations with their district counterparts were not good. They attributed this in part to district officers' unhappiness at the loss of the disposal function, and in part to the fact that district officers were excluded from certain discussions about landfill site developments. County officers pointed to the failure of districts to provide data on collection costs for county use as evidence of poor relations.

The view was expressed by county staff that district councillors shared their officers' animosity towards the county. This was seen as partly responsible for the rather parochial point of view often expressed by district councillors when waste disposal operations threatened to impinge on their constituents.

b) Existence of a Planning Activity

County officers were introduced to the definition of planning used by Ackoff (1970, P.1) "Planning is the design of a desired future

and of effective ways of bringing it about". They agreed that this coincided with their understanding of planning, and stated that waste management planning in the Ackoffian sense was going on in the county.

County officers indicated that they were the planners. It was felt that councillors were not seeking to become involved and would continue to be content to respond to the waste disposal group's suggestions. Officers further stated that the Chairman of the relevant council committee, the Planning and Transportation Committee, was interested in waste disposal and was usually willing to support the waste disposal group's point of view. Officers indicated that although they were hoping to produce a waste disposal plan of the type referred to in the Control of Pollution Act, councillors would not be involved in its preparation. They indicated that they were not planning because councillors had asked them to do so, but because they felt it appropriate. They argued that since councillors had sanctioned the appointment of a member of staff to carry out the industrial waste survey and some planning activity, councillors were aware that planning activity was going on and that that was all that was necessary.

County officers indicated that district officers were keen to be involved in the county waste management planning activity but that their participation would be limited to commenting on a draft plan when one was produced.

c) Problem definition

County officers indicated that they saw themselves as being in the business of waste disposal. An alternative definition of the waste management task as involving waste processing was suggested by the interviewer, but the officers indicated that using waste was a secondary issue. Ensuring that waste could be disposed of was clearly seen as having priority. Cost to the community was not mentioned by the county officers initially. However cost considerations were obviously relevant to them and featured throughout later discussions.

Constraints which had to be taken into account in making disposal decisions were identified by officers as:

(1) An environmental constraint

(2) The need to locate disposal sites close to districts.

d) Measures of Effectiveness

County officers did not offer many specific comments about measures of effectiveness. Ability to dispose of waste, of course, is relatively simple to measure in terms of capacity in tonnes. But the same is not true of environmental impact. Here there are many possible dimensions of measurement. It may have been the case that county officers relied on public protest to identify the

relevant dimension of environmental impact for a particular disposal activity. There was some suggestion of this during discussions, but the issue did not appear to have been thought through.

Some attempt had been made to make the criterion "close to the districts" more specific. The phrase was taken to mean, within an acceptable radius of the centre of gravity of population of each district council. Use of a compensation formula in dealing with districts ensured that this criterion was taken into account in decision making.

e) Forecasting

County officers freely acknowledged their lack of information about waste amounts. They indicated that districts had not collected data prior to 1974 and that since then data collection efforts by the county had been limited.

It appeared that, since 1974, three data collection exercises had been undertaken:

(1) For one week in 1979, every vehicle entering the six landfill sites was weighed. On this basis, county officers estimated that the county was disposing of 118,000 tonnes of domestic and commercial waste per annum. At that time this

was equivalent to 0.24 tonnes per head of population per annum. Officers hoped that this exercise would be repeated, but emphasised its unpopularity with collection staff.

(2) A waste composition analysis was contracted out by the county to one district on two occasions. This was done at the request of the D.O.E.. County officers regarded the cost as excessive, but were considering repeating the exercise.

(3) A questionnaire based industrial wastes survey examining waste produced by manufacturing industry had been administered. County officers estimated that the sample of firms contacted employed approximately 92% of the county's workforce.

County officers were loath to commit themselves to a forecast of future quantities of waste. They indicated that poor data availability rendered such an exercise meaningless. However, during discussion it became apparent that belief in a particular forecast - that of little change in waste generation rates over the next ten years - was current. The source of the forecast could not be identified. County officers claimed that the ambiguous nature of the forecast was unimportant since available landfill space could cope with significant changes in waste quantities.

f) Strategy Generation, Evaluation and Choice

County officers indicated that although landfill was seen as the key disposal method over the next ten years other disposal technologies had been or were being considered. Incineration, prior to landfill, had been rejected on cost grounds after only a cursory examination, but medium density baling was seen as attractive because it would improve waste handling characteristics on landfill sites. The possible use of transfer stations had also been examined, but no cost reduction over long haul in collection vehicles had been identified. County officers indicated that lack of cost data had hindered this analysis. County officers indicated that further consideration of alternatives to landfill need not take place for perhaps three years.

g) Alternative Generation, Evaluation and Choice

County officers indicated that their local knowledge was an adequate source of information about possible landfill sites. They indicated that no formal survey of potential landfill sites had been carried out. Sites close to centres of population were investigated and, if suitable, were acquired for use. Some were leased and some purchased. The attitude of the owner seemed to be the determining factor. Economic appraisal of alternatives appeared to be minimal. Use of computer evaluation methods had been considered, but the cost was regarded as prohibitive.

h) Monitoring Implementation

County officers indicated that implementation problems were present but not serious. Water authorities were typically consulted about the proposed acquisition of a landfill site at an early date, and because of the high standard of site management produced by county officers, were becoming relatively amenable. Pressure from environmental groups had been experienced on one or two occasions in the past, but the county had felt able to compromise and defuse the situation.

i) Interviewer's Evaluation

This is a small waste disposal group which inherited a strategy of landfill on reorganisation and also inherited the resources to allow the strategy to continue in operation. Unless there is vast increase in industrial development or a major increase in population (both unlikely) existing landfill sites should cope with waste for approximately ten years. Furthermore, new landfill sites should also easily be obtainable close to existing sites when they become necessary.

Despite the claims of officers, it appeared that analysis/planning was backward rather than forward looking. Problems in carrying out the landfill policy had generated the interest in baling and transfer. There was no attempt to ask what other strategies were possible, only to ask how the present strategy could be maintained. Reclamation was not considered seriously and the examination of incineration had been cursory.

It is difficult to imagine this county changing its pattern of operations without major outside pressure.

7.3 County 'B'[4]

a) Background

In 1974 this shire county inherited more than twenty landfill sites, three pulverisers and an incinerator. Unfortunately the landfill sites were all close to the end of their lives and without exception their use had to be discontinued within a year. Use of the pulverisers and of the incinerator was also quickly halted on grounds of cost. This left the county with a clean sheet. At that time, county officers decided to commission new sites and to operate a policy of controlled landfill. In 1980 landfill, together with some transfer of waste, remained the policy. However capacity shortage was a major problem.

County officers indicated that relations with their district counterparts were good, but that problems existed at councillor level. These county/district links will feature in the discussion of implementation problems.

b) Existence of a Planning Activity

County officers indicated that Ackoff's definition of planning coincided with their own understanding of the activity. They also indicated they were involved in planning in this sense.

c) Problem Definition

County officers said that they saw their task as one of waste disposal. They identified cost of operation as an important factor

in deciding on type of disposal operation. There was an indication that they felt that a broader definition of the waste management function would be difficult to 'sell' to councillors, given that the 'simple' task of waste disposal was proving difficult to cope with.

County officers indicated that they regarded themselves as constrained when pursuing their objectives by a need for their disposal operations to be flexible. They interpreted this word as meaning capable of coping with changing circumstances. Officers also identified a concern with environmental issues.

d) Measures of Effectiveness

County officers did not know how to measure flexibility of a strategy or option. Further, although they were aware that environmental impact had many possible dimensions, they had not specified which dimensions were important to them and how performance along these dimensions should be assessed. Only in the case of cost was there anything like a clearly defined and accepted measure. This was cost per tonne.

Cost per tonne was seen as important because, on this measure, the county compared badly with others. Councillors had apparently become aware of this comparatively poor performance, and thus cost per tonne had come to be seen as a key yardstick of performance. County officers indicated that comparative performance was not so bad if another cost measure such as cost per mile was used. However they also indicated that because of the political sensitivity of cost per tonne other measures were largely irrelevant.

e) Forecasting

County officers stated that in 1974 the weighing of waste had been the norm. They claimed that the percentage of waste weighed was among the highest in England and that therefore they had a good knowledge of the present amount of waste being disposed of. This claim appeared valid with approximately 69% of waste disposed of by the county in 1978 - 79 being weighed. Officers indicated that an industrial waste survey had just been completed and that therefore once again their knowledge of the current situation was relatively good.

County officers clearly had a view about future amounts of refuse; they anticipated a small percentage increase. However there was no objective method underpinning the forecast. Equally subjective forecasts about, for example, levels of recycling activity by the private sector, were also presented by county officers.

f) Strategy, Generation, Evaluation and Choice

County officers indicated that in the immediate post reorganisation period, a strategy of controlled landfill had been adopted. Evaluation appeared to have involved two criteria, cost and availability of capacity. Cost data used had been that publicly available at the time, while the feasibility of the strategy had been decided on the basis of a county wide survey of potential tip sites. Officers indicated that in retrospect the criteria for deciding on whether a site was potentially available for landfill had been too concerned with hydrological and engineering issues.

When county officers were first contacted by the author, the landfill strategy was still seen as valid. The serious lack of landfill space facing the county was seen as relating to implementation problems rather than strategy selection. At that time county staff were talking in terms of spending time producing a planning document for the D.O.E. even though their planning "was completed" and they would derive no benefit from producing the document.

However at a meeting some ten months later officers indicated that they no longer regarded themselves as committed to landfill and that alternatives were being considered.

g) Alternative Generation, Evaluation and Choice

County officers were aware of the investment appraisal advice contained in D.O.E. publications. On two occasions the present author was asked for his opinion of elements of the D.O.E. advice. However the county officers did not appear to have experience of applying investment appraisal techniques. It is possible that pressure on landfill capacity was so great that availability of a site almost rendered economic evaluation unnecessary.

It was interesting to note that in 1980 a consultancy group was about to undertake a study of a proposed new transfer station system. The study proposal involved the use of mathematical programming models. The consultants were being employed against the wishes of the county waste disposal officers, who felt themselves capable of carrying out the analysis. County officers were however willing to concede that

there might well be a benefit in using an outside consultant in that councillors might accept a consultant's recommendations more easily than those put forward by county officers.

h) Monitoring Implementation

County officers stated that it had proved extremely difficult to implement the landfill strategy. They indicated that although districts in the pre-reorganisation period had appeared to experience no difficulty in acquiring landfill sites, the county was experiencing much difficulty and delay. County officers identified the following obstacles in the way of site acquisition:

(1) Public opposition made it difficult to get planning permission on new sites.

(2) Existing owners of void were exploiting the shortage by charging high prices per cubic metre. The county was in competition with other tip operators for this scarce resource and hence had become involved in lengthy negotiations with owners of void.

(3) The county had not pursued the "compulsory purchase order" option as vigorously or as often as county waste disposal officers would have liked.

(4) The county planning department had not allowed the waste disposal group to pursue several sites in the same area simultaneously. Therefore failure to acquire a site left the waste disposal group back at square one.

(5) Planning permissions on landfill sites had start and finish dates included. The county planning department supported a quick return of the site to use. This conflicted with the waste disposal group's attempt to build up a five year land bank.

(6) District councillors often took the view that waste from other districts should not come into their area.

County officers felt that these implementation problems had prevented the landfill strategy from functioning. They indicated that steps had or were being taken to reduce implementation problems, but that the difficulties that remained were likely to inflate the cost of the landfill strategy.

The county's response to the waste disposal group's problems had been organisational: A separate sub-committee of the Highways Committee had been set up specifically to deal with waste disposal matters. An officer working group with members drawn from several departments had also been created, and finally a new site acquisition group had been set up within the planning department.

(i) Interviewer's Evaluation

At first sight counties A and B appear rather similar. Both are shire counties, emphasising disposal rather than reclamation activities, making use of landfill, and not anticipating a rapid rise in the amount of waste to be disposed of. In county A, this combination led

to a stable state, while in county B, the result was almost chaotic. Clearly, shire counties need not have similar outlooks.

The situation in county B was difficult to interpret. Despite acceptance of Ackoff's definition of planning, officers were clearly trying to work to a strategy blueprint. All effort was being directed to implementation problems associated with existing strategy and none to the development of alternative strategies. However there is some indication that the emphasis might have been shifting.

There was obvious councillor concern with the waste disposal problem, but little involvement. Councillors seemed to want to respond to officers' suggestions. It is interesting to note that a decision to use an outside agency, despite the objections of the waste disposal group, was made by the council. This may well have short-term benefits, but does nothing to direct attention away from implementation issues.

7.4 County 'C'(5)

a) Background

In 1974 this shire county inherited two dry pulverisors. These however were shut down because of high operating costs. Initially county officers allowed districts to continue to operate landfill sites under agency arrangements, but in 1977 took over full responsibility for these operations. County officers indicated that 50% of the tip sites taken over were still in use in 1980.

County officers indicated that they had good relations with district officers and took pains to involve them in the early stages of decision making.

b) Existence of a Planning Activity

County officers appeared to hold the view that planning meant 'ends related' rational planning. They indicated that as far as they were concerned, planning was a continuous activity, and that a key element in planning was to make the plan workable.

The planning requirements of the Control of Pollution Act caused the county to seek to employ a consultant to assist county staff. The consultancy project was put out to tender in late 1978. The task description circulated to interested firms identified county objectives, strategies to be analysed, and requested proposals which emphasised a computerised approach. The job description emphasised that data collection and preparation of a planning document would remain the task of county staff.

Four firms of consultants were contacted and asked to submit proposals. In the event, the contract was awarded to L.G.O.R.U.. County staff indicated that the fact that L.G.O.R.U. had carried out similar projects in other counties was a significant factor in their decision.

c) Problem Definition

County staff indicated that they saw their task as one of waste disposal. They indicated that disposal at least cost to the community while taking account of environmental impact was their aim. County staff indicated that reclamation activity was not out of the question, but that as a practical matter, cost probably made the issue irrelevant.

d) Measures of Effectiveness

County staff did not appear to have considered how to translate their overall objectives into performance measures. Indeed, it seemed that the outside consultants were to be charged with this translation task. The request for tenders stated that the consultants should recommend an appropriate method of analysing and evaluating options and should specify data input requirements and a planned pattern of outputs.

The need to find operational measures of performance was however not lost on county staff, witness an attempt to provide such measures for a later analysis of civic ammenity site provision. Table 7.4.1 lists criteria considered relevant to the analysis and also chosen performance measures.

TABLE 7.4.1

Performance Measures in County 'C'

Objectives	Measurement
1. To minimise the overall cost of the operation. a) overheads and management b) plant and vehicle operation c) labour d) services (telephones, electricity) e) revenue effects of capital expenditure f) maintenance of site g) income h) provision for breakdowns/ emergencies	Annual cost
2. To minimise dumping in unauthorised places (to provide the optimum number of sites)	Cost to the community
3. To minimise unauthorised totting	Number of occasions and number of persons concerned
4. To make the site acceptable to the public using it	a) Regular Inspection b) Number of complaints
5. To ensure that the presence of the site is not a serious detriment to the amenity of the locality	a) Regular Inspection b) Number of complaints
6. To minimise the likelihood of vehicles queueing on the public highway	a) Regular Inspection b) Number of occasions and vehicle numbers
7. To ensure the site operation is safe	a) Regular Inspection b) Number of accidents
8. To minimise the occasions the sites are closed for emergency reasons	Number of occasions

Concept (not in order of priority)

1. The public should be able to dump their rubbish quickly and easily.
2. The skips must be capable of clearance by County Council and Contractors.
3. The sites must be manned and have regular opening hours.
4. The operation and clearance of the site must be cost effective.
5. The sites must be kept reasonably clean and tidy.
6. Income must be maximised.

e) Forecasting

In 1976 - 77 the county carried out a survey of industrial waste. The survey covered about 44% of employees in the county. Officers stated that it was possible to estimate total industrial waste produced within the county on the basis of this figure. As far as domestic waste was concerned, county officers had available:

(1) Data based on regular weighings of waste passing through one transfer station.

(2) Data based on a single weighing of all waste delivered to county landfill sites during a one week period. Portable weighpads were issued for this exercise. It was planned to repeat the exercise at a later date.

(3) An annual refuse analysis carried out by one district.

County officers felt that these data were sufficient to generate a reasonably accurate picture of future amounts of waste. The officers stated that as far as domestic waste was concerned they anticipated no dramatic change over the next 25 years. The forecast was clearly subjectively generated. The officers were less willing to produce a forecast for industrial waste. They felt that more data, based on further survey exercises, were required.

County officers indicated that forecast accuracy was relatively unimportant to them and that an error of 10% would be regarded as of minor concern.

f) Strategy Generation, Evaluation and Choice

In the document sent to the four consultants, county officers identified several strategies to be examined. These emphasised continuation of a landfill policy. The strategies varied only with respect to the type of site which would be considered available for landfill. The other strategies the consultants were asked to examine were:

(1) The absolute minimum cost solution.

(2) The strategy which minimises the need for landfill sites.

(3) The strategy which maximises the recovery of materials from waste.

County officers suggested that strategies could be compared in terms of capital and revenue consequences, with environmental consequences also being taken into account. At a later stage in the document, county officers also indicated that sensitivity analysis should be undertaken.

(g) Alternative Generation, Evaluation and Choice

County officers indicated that detailed evaluation of alternatives was the task of the outside consultants. However county officers clearly felt that it was their province to define these detailed

alternatives. They also provided the consulting group with an indication of which costs should be taken into account. The range of relevant costs is identified in Figure 7.4.1.

When first contacted by the author, county officers were receiving initial computer outputs from the consulting group. The volume and complexity of this output was causing problems. At a later stage in the discussions it was stated that the approach to evaluation adopted by the consultants seemed excessively complex and that a simpler evaluation model based simply on haul distance would have been just as good. Still later, county officers indicated that with the assistance of county computer staff they were attempting to develop such a model.

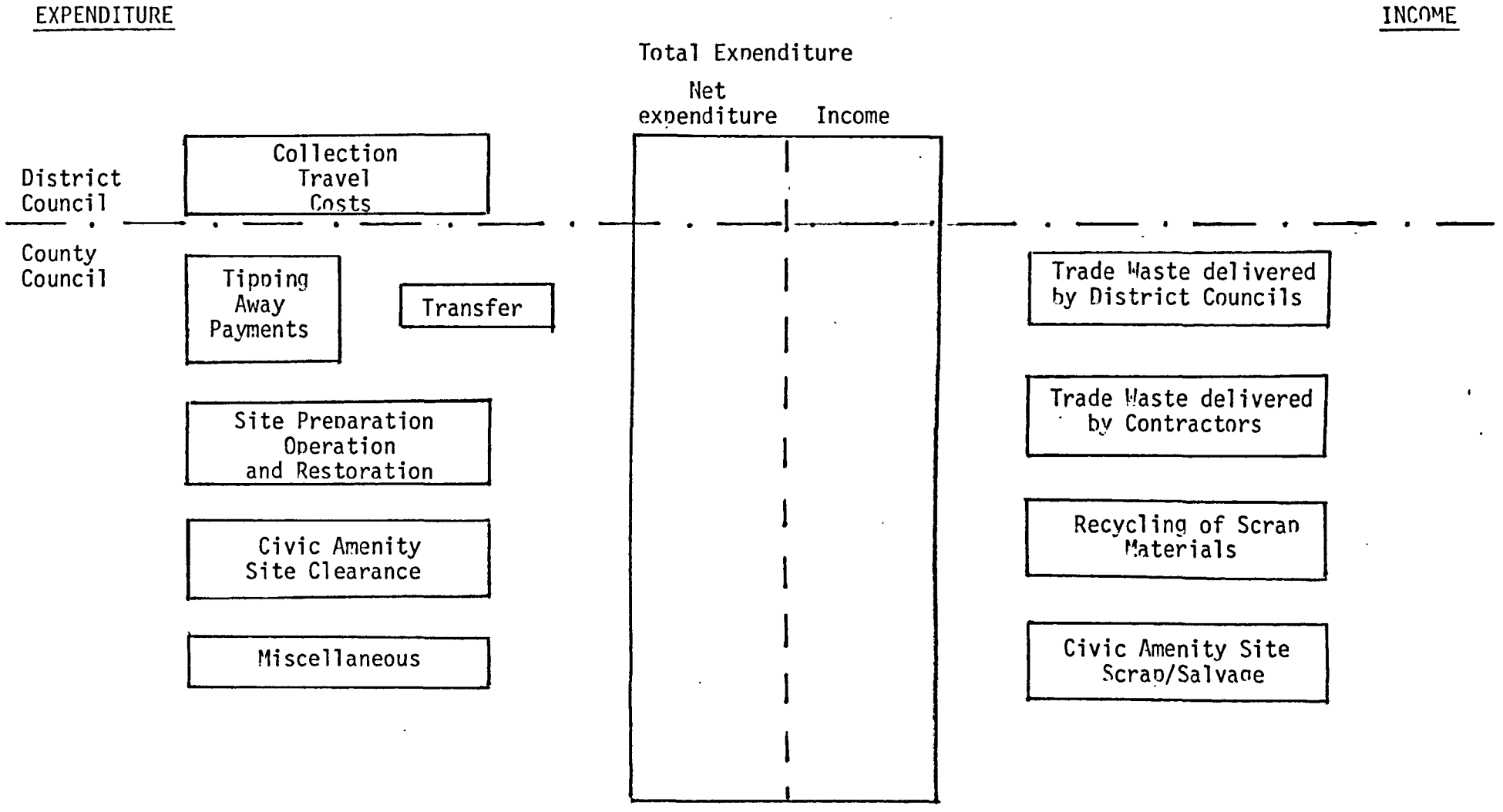
The preference for using distance data rather than cost data was said to stem from the idea that costs were directly related to distance and the idea that distance data was more easily available and more reliable than cost data. During further discussion it became clear that county officers implicitely assumed that alternatives would not differ substantially in terms of capital cost and that therefore a comparison of running costs would be sufficient.

h) Implementation

County officers indicated that in the past there had been no difficulty in implementing the county landfill policy. This was due to the fact that there was a large and increasing amount of tipping space in the county. The increase stemmed from the activities of

FIGURE 7.4.1

DIAGRAM OF RELEVANT COSTS AND INCOME FOR COUNTY 'C'



mineral extraction companies. County officers stated that although there were water problems in some areas of the county, a policy of cooperation with the local water authorities generally led to a suitable site being found. It was also stated that public opposition to landfill sites was minimised because tip sites in the county were operated to very high standards. Some concern was expressed that budget cuts might cause standards of operation to be trimmed, but it was felt that even so, public opposition to landfill sites would remain limited. County officers indicated that they saw no reason why implementation problems should increase in the future.

i) Interview Evaluation

Throughout discussions with county officers it was clear that in their view landfill was the most appropriate disposal strategy. It was seen to be cheaper and easier to operate than others. To the interviewer it seemed that the entire planning activity was designed to support this view. This fact was most apparent in the range of strategies offered to the outside consultants for examination. Mixed strategies were not included. Essentially the strategies reduced to:

(a) Minimise costs by maximising direct landfill

(b) Maximise costs by maximising resource recovery prior to landfill.

Given the emphasis on disposal at least cost in the objectives which the county provided to the consultants, the choice of strategy was hardly in doubt.

The use of outside consultants seemed to be more related to a need to ensure the respectability of county officers' recommendations to committee, rather than to a need to introduce outside skills into the analysis process. This same tendency to close discussion rather than open it up was also evident in officers' comments about the type of planning document which it was proposed to produce. It was to be short, simple, and to emphasise conclusions and the feasibility of the chosen strategy.

It is interesting to note that councillors were seen as a barrier, a group to be circumvented rather than involved.

7.5 County 'D'[6]

a) Background

In 1974 this shire county inherited twenty-two landfill sites, one incinerator and two pulverisers. Within two years the pre-treatment plant had been discarded and only eight of the landfill sites were still in use. Since some of the remaining landfill sites were approaching the end of their useful lives, the waste disposal group embarked on a programme of new site acquisition. The decision to continue with landfill was, as will be seen, the result of careful analysis.

The policy of landfilling was continuing in operation in 1980. Sites were being operated by the county and by outside contractors. The county was on the way to developing a landbank giving waste disposal capacity for a 25 year period in most areas of the county.

b) Existence of a Planning Activity

County officers indicated only partial agreement with Ackoff's definition of planning. They appeared to read into Ackoff's phrase "design of a desired future" a very detailed exercise. They indicated that to them planning involved "the construction of a model of a desired future", a cruder exercise and then the design of that future". With that reservation, county officers indicated that they did plan.

County officers indicated that the adoption of a landfill policy had been preceded by a detailed analysis on the part of county staff and

prior analysis by an outside consultant, L.G.O.R.U. They indicated that since that time no new events had necessitated a policy change. County officers indicated that they did not intend to produce a planning document, but if necessary could do so "in a weekend".

c) Problem Definition

County staff indicated that they saw their department as being in the business of waste disposal. Constraints taken into account in pursuing the waste disposal activity were stated to include:

(1) Desirability of minimum cost operations.

(2) Need to protect the environment.

(3) Need for the disposal system to be flexible.

d) Measures of Effectiveness

Waste disposal officers claimed to identify specific measures that could be used to evaluate strategies. They pointed to reports to committee which provided either examples of specific measures or definitions. Examination of these reports indicated that economic measures such as cost per tonne and total annual cost were being calculated. A wide range of measures of environmental impact could also be identified in a statement of a code of practice for the operation of landfill sites.

One report to committee which officers produced identified a measure for flexibility. A flexible disposal option was defined as

one which involved "minimum capital expenditure and commitment to plant and buildings".

e) Forecasting

County officers indicated that they did not expend much effort in collecting data about current amounts of waste produced. For an estimate of domestic waste produced per head of population, they relied on weight of waste figures coming from the three contract sites. The source of data about industrial waste was identified as a survey carried out with the assistance of an outside body shortly after reorganisation. Officers indicated that it had been intended to update the industrial waste survey but that staff shortages had prevented this.

County officers indicated that the lack of a detailed knowledge of current waste amounts was not a cause for concern. They further indicated that they did not prepare forecasts of future waste amounts and that again the lack was not considered important. The key point made by officers was that the chosen strategy of landfill was not sensitive to variations in future waste amounts. County officers stated that while they paid little attention to forecasting future waste amounts, they produced detailed forecasts of the remaining life of landfill sites. They indicated that these forecasts were updated frequently.

f) Strategy Generation, Evaluation and Choice

Prior to local government reorganisation, the local district councils

employed L.G.O.R.U. to prepare a report on waste disposal for the proposed county. The resulting report included an evaluation of various disposal/reclamation technologies. The evaluations touched on:

(1) Practicality and reliability of the technology.

(2) Impact on the environment, with special reference to water pollution.

(3) Impact on speed and quality of land reclamation.

(4) Impact on level of recycling activity.

(5) Impact on the county's budget.

The L.G.O.R.U. report concluded that landfill within the county would be exhausted by 1980. Two alternative strategies, one of which coupled landfill with transfer station operations, and another which emphasised incineration, were suggested. County officers later reappraised the landfill strategy. They came to the conclusion that the consultants had erred in stating that landfill capacity would be exhausted by 1980. According to county officers, L.G.O.R.U. had used inappropriate criteria for assessing likely availability to the county of sites potentially capable of being used for landfill. County officers indicated that they had not re-evaluated the other technologies examined by L.G.O.R.U.

An initial element in county strategy was a willingness to cooperate with the private sector. Owners of sites were allowed to run waste disposal sites which the county used. However, officers stated that they had come to the conclusion that there were great benefits in terms of security from the county operating some sites itself and not being totally dependent on a private sector operator.

g) Alternative Generation, Evaluation and Choice

The L.G.O.R.U. study involved a computer analysis of perceived alternatives. However, later county efforts used ammended procedures for alternative generation and evaluation. County officers indicated that site identification now involved the use of aerial surveys, but that this increased sophistication in identifying alternatives had been accompanied by the adoption of much cruder evaluation procedures. Despite the fact that this county's disposal costs per tonne were significantly higher than those in some similar counties, cost considerations appeared to play only a minor part in evaluating alternatives. One county officer stated that there always seemed to be factors other than economic ones involved in decisions. During further discussion, he and other officers, indicated that considerations of security of operations frequently outweighed those of cost economics.

h) Monitoring Implementation

County officers acknowledged that their landfill strategy could face implementation problems. They stated that this was partly

because they were in competition for sites with the private sector, and partly because of factors such as the time before a potential site became available for use. County officers did, however, argue that one potential implementation problem, namely public opposition, had been minimised by their efforts. They argued that a high standard of controlled tipping had generated substantial public confidence. Similarly the officers argued that time spent in cementing relations with public bodies, such as the water authorities, and even with the county planning department, had minimised site acquisition problems. Officers argued that it was L.G.O.R.U.'s failure to consider factors such as these which rendered their strategic analysis irrelevant.

Relations with district officers appeared to be handled at arms length. Application of a compensation formula protected districts from the adverse financial consequences of county decisions.

i) Interviewer's Evaluation

This set of interviews raised several issues. Firstly, officers clearly saw planning as a two stage process, a preliminary broad brush analysis, followed by a more detailed activity. Secondly, the bulk of planning activity had involved a detailed examination of one strategy option. A third important feature was the idea that flexibility involved not committing resources. Alternative methods of maintaining flexibility did not appear to have been discussed.

A final interesting feature was the link between this county's

experiences and those of county B. Each county's attempt to adopt a landfill strategy had highlighted the issue of feasibility. County D had been advised to abandon landfill on feasibility grounds but by giving attention to implementation had generated feasibility. County B was attempting the same approach, but with less success. In each case, an outside consultant had become involved.

7.6 County 'E'[7]

a) Background

Metropolitan county E inherited an integrated waste disposal system in 1974. This was due to the fact that in the late 1960's, many of the local authorities in the area voluntarily collaborated to deal with waste. They employed a consultant, L.G.O.R.U. once again, to identify an appropriate approach. The study which was carried out, recommended the construction of five incinerators, four of which were in fact built.

In 1974, the new county decided that the four incinerators in existence offered sufficient disposal capacity. Therefore plans for the fifth incinerator were abandoned. In 1980 the four incinerators were still in operation and coping with most of the waste produced within the county. They were assisted by a transfer station, and a newly commissioned reclamation plant.

The reclamation plant produced a pelletised waste derived fuel. Further reclamation activity took place at the incinerators where metal recovery after burning was carried out. Any residue, together with any unprocessed waste was taken to landfill.

b) Existence of a Planning Activity

Officers claimed that planning went on in the waste disposal group continuously. They also claimed that planning was difficult because

some inputs to the planning process were so uncertain. One officer stated that:

> "The only firm planning you can do is where you know the facilities on which you are basing your plan will definitely be available".

Such a view obviously shortens the time horizon of any planning exercise. Officers frequently mentioned the desirability of having a 'firm' plan.

Officers were particularly scathing about the D.O.E.'s emphasis on the production of a written plan. They argued that since much of the relevant information was generally available in a county structure planning document, the only reason to emphasise the written document was to ensure that relatively inexperienced officers in small authorities were forced to go through some form of planning exercise.

Officers were asked their opinion of the pre-reorganisation L.G.O.R.U. study. They acknowledged that the consultant's work had been substantial, but wondered if a similar solution to that proposed could not have been arrived at more easily. They did, however, state their belief that the involvement of outside consultants probably made it easier for officers to get the proposed solution accepted by councillors.

c) Problem Definition

This county had available a policy document covering all aspects of the county's operations. It included a list of objectives for each type of county activity. Objectives relating to environmental management include:

(1) Reclamation of derelict land.

(2) Persuading industry to reduce all types of pollution.

(3) Making the best use of any products (including heat) which can be derived from waste materials.

This third objective was strongly supported by officers of the waste disposal group, who it is claimed, were instrumental in convincing councillors that the county should extract the maximum amount of usable material from refuse before disposal. Officers in fact indicated that disposal without some attempt at reclamation was strongly discouraged.

d) Measures of Effectiveness

Explicit measures of effectiveness did not appear to have been developed. It was argued that environmental soundness and practicability were amenable to common sense interpretation. On being questioned about the lack of a cost measure, officers indicated that cost was measured on a comparative basis. They argued that for

reasons beyond their control, principally the fact that they inherited incineration plant, county E operated a high cost disposal system. Therefore, they argued, all cost reductions were seen as welcome, and their aim was to ensure that costs declined or at least did not rise.

e) Forecasting

Officers indicated that the amount of domestic waste produced in the county was known since all waste was weighed prior to incineration. They indicated that an analysis of waste composition was done on a yearly basis. County officers indicated that they expected the amount of domestic waste to grow but at less than 2½% per annum. They saw this as only a slight increase, and indicated that they had taken into account factors such as a declining population in producing the forecast. County officers further stated that they did not expect the composition of waste to change significantly over the next ten years. Further discussions with officers indicated that the forecasts of waste quantity and composition were produced subjectively. A relatively large data base had been examined, but the process of translating past data into a forecast was not explicit.

Officers indicated that they did not have a time series of data on industrial waste comparable to that for domestic waste. They stated however that they had carried out a comprehensive industrial wastes survey in 1975. All large firms and 90% of small firms in the area were surveyed. County officers stated that there were no plans to update the survey, but their knowledge of local developments, would

be sufficient to make them aware of any likely major changes in industrial waste production.

f) Strategy Generation, Evaluation and Choice

Officers indicated that for two reasons a wide ranging examination of disposal/reclamation technology was perpetually going on. These were that a shortage of landfill space made some form of waste treatment essential, and secondly that incineration, the treatment process in use, was the most costly possible. Officers indicated that technologies were evaluated against three criteria:

(1) The extent to which landfill capacity is required.

(2) The extent to which the technology allows reclamation of materials.

(3) Cost in relation to that of incineration.

Application of these criteria led, for example, to the rejection of the direct landfill option and of the high density baling option. The only technology which survived this evaluation was apparently the production of a refuse derived fuel. Possibly, the willingness of the D.O.E. to part finance the construction of a plant had something to do with the survival of the option. That factor apart, however, officers stated that the existence of a market for the fuel had been checked and that costs of operation seemed likely to be less than those for incineration.

A further factor which appeared to work in favour of the refuse derived fual plant was the ability to build in flexibility. It was decided to reclaim ferrous scrap from the waste stream as well as to produce refuse derived fuel. This lessened dependence on one market. It was decided to build the plant so that the basic structure could be used to house a transfer station if the reclamation project proved unsuccessful, and so that it could be extended if the reverse proved true. Finally officers stated that the plant had been designed to operate satisfactorily over a range of patterns of waste composition. Officers indicated that they were particularly concerned about reductions in the quantity of paper in the waste stream.

g) Alternative Generation, Evaluation and Selection

Clearly, the way in which officers handled the issue of flexibility indicated that it was almost an alternative to a more formal evaluation of a detailed option. In fact officers indicated that they paid little attention to this area of activity. They stated that there were seldom choices to be made in moving from general strategy through to specific alternatives, and that therefore evaluation and selection were irrelevant. Officers were asked whether a lack of alternatives was also the case when considering landfill options for residual waste. They indicated that this was so.

h) Monitoring Implementation

County officers identified several potential problems. These

related both to the waste treatment technologies in use and to the landfilling of any residue. As far as the use of the mechanical plant was concerned, they pointed to the high breakdown rate of the incinerators, and the dependence of the incinerators and the refuse derived fuel plant on the presence of paper and other combustibles in waste. As far as landfill space was concerned, they pointed to a conflict of objectives between the waste disposal group and the county planning department, and also to problems with local environmental groups. Despite the fact that waste disposal had been designated a high priority function by the county council, officers felt that county planners did not appreciate the urgency of the waste disposal group's needs for large landfill sites which could be held against future needs. However, officers indicated that relations between county and districts and between county and water authorities were amicable.

i) Interviewer's Evaluation

The waste disposal group in this county was dominated by its chief officer. Any planning/analysis activity centred on him. Generally procedures were informal and ill-defined. The interviewer felt that the impending retirement of this officer would leave the waste disposal group with no alternative but to tinker with past policies while they attempted to learn how to cope with the future.

What attempts were being made to plan were rather difficult to characterise. There appeared to be a recognition that officers could not establish an unchanging blueprint for the future. Further, there

was an attempt to build flexibility into strategies. However at times officers seemed to describe what they were doing as something to be done because uncertainty rendered planning impossible. It was almost as if they would have liked to establish an unchanging blueprint, and that this was their concept of planning. To the author, a most interesting aspect of the county's operation was the freedom of choice enjoyed. Officers clearly felt that they could consider anything and everything because nothing could be as bad as incineration.

7.7 County 'F'(8)

a) Background

This metropolitan county inherited six incinerators, two pulverisers and tipping capacity for approximately four years from the districts in 1974. In 1980 all the plant, with the exception of one incinerator was still in use. At that time, officers anticipated that the remaining incinerators, had a potential life of another fifteen years. Since local government reorganisation, the pattern of operations had been ammended to include transfer operations. At the beginning of 1980, county officers indicated that they were operating twelve landfill sites, which gave them enough landfill capacity for about two years.

b) Existence of a Planning Activity

Officers indicated that the waste disposal group was involved in a planning activity. Although they identified points in time when a major planning effort had been completed, such as on completion of input to the county structure plan, they claimed that planning was a continuous activity. Officers claimed that they saw their planning activities not solely in terms of a response to current problems but also as an attempt to develop the capacity to cope with a predicted future. They indicated that they were aiming to produce a written plan for the D.O.E., but that the objective of the exercise was more to focus their own attention on long term issues.

There was little evidence of a pronounced councillor input to the planning process. The officer group seemed to take the lead and make

recommendations. Councillors then either accepted the recommendations or returned the issue for further consideration. Councillors seemed to be regarded by officers as outside the planning activity.

c) Problem Definition

Officers indicated that they tried to look on refuse as a resource to be used in the best way possible rather than as something to be disposed of as cheaply as possible. Officers indicated that they attempted to consider both domestic and industrial wastes. County officers acknowledged several constraints on the way in which they pursued the overall objective. These included:

(1) Cost.

(2) Implied demand for landfill capacity.

(3) Environmental impact.

The above constraints featured in various reports to committee. One constraint which did not appear to be discussed in the reports made available, but which did feature in comments made by officers, was the need for flexibility, the ability to function under changed circumstances.

It should be noted that officers did not commit themselves to reclamation to the same extent as their counterparts in county E. Rather they left their options open. However there was some indication

that officers did have a preference for using a reclamation technology.

d) Measures of Effectiveness

County officers claimed to have available to them a list of measures of effectiveness. However the list was simply a restatement of the constraints described in the previous section. The key idea of 'making use' of waste did not appear to have a measure associated with it. Those measures which did exist, except for capital cost and total disposal cost per tonne, did not appear to offer much guidance for ranking alternatives. It appeared that a relatively subjective, better/worse, ranking was all that was possible.

e) Forecasting

Officers were prepared to quote a figure for the amount of domestic refuse produced within the county area. However they emphasised that the figure was a crude estimate only. They indicated that in the past, efforts at measurement had not been given enough attention, and that in any case methods of measurement were rather crude. County officers indicated that they felt that receptacle counting, whether the receptacles were dustbins or collection vehicles, was of little value. However they admitted that collection vehicle counts at landfill sites, together with weights taken at incinerators, were the basis of the estimate. Officers indicated that they intended to purchase additional weighing equipment to improve their estimate of the amount of domestic waste being produced.

Given the lack of knowledge about the current level of domestic waste, it is perhaps not surprising that officers had little information about the composition of waste. Officers indicated that they were not aware of any local studies, and that they relied on previously published national statistics.

A survey of industrial wastes was begun in 1979. Officers estimated that it would be completed by Spring 1981. They indicated that the intention was to contact 2000 firms. The large number of contacts was said to be necessary because of difficulties in grossing up sample figures.

Officers indicated that their database was seen as inadequate for forecasting purposes. They stated that although they regarded accurate forecasting of both waste quantity and composition as important, their own forecasting was limited. They indicated that they intended to operate on the assumption that they would have to dispose of 1.5 million tonnes of waste per annum over the next ten years. During discussions it became clear that the forecast would be self fulfilling, since the county intended to adopt a policy of turning away industrial waste should that become necessary. The selection of the figure 1.5 million tonnes appeared to be based on a subjective view that this would take into account likely changes up to a ten year planning horizon. As far as waste composition was concerned, a subjectively produced forecast of no change appeared to be held.

The quality of the available forecasts appeared to be a source of

concern to county officers. They indicated that while they would be adequate for a county pursuing a landfill policy, there would be considerable risk in basing a plan involving treatment plant on them. The lack of a good forecast of composition was seen as particularly crucial to the treatment plant issue. The view that production of good forecasts was seen as important by officers was supported by the attention given to forecasting waste in the county structure plan. This document suggests an approach to forecasting by outlining social and economic factors which might affect waste quantity. It also comments on possible factors affecting waste composition. While the plan did not contain forecasts explicitely based on such factors, it seems reasonable to suggest that the subjective forecasts current among county officers were based on them.

Apart from waste amount and waste composition, other waste related factors were of concern to officers. They held the view, that there would be a continuing shortage of conveniently located landfill sites. Also they held the view that throughout the economy there would be a trend towards the use of low grade fuels. There was a large subjective element in both these forecasts.

f) Strategy Generation, Evaluation and Choice

Officers stated that the county's strategy was to continue using landfill and existing treatment plant (mainly incinerators) in the short term, but to aim to minimise the direct tipping of refuse in the future by investing in treatment plant and bulk haulage facilities. Officers indicated that shortage of landfill was likely to be a severe constraint on operations in the future.

The selection of a type of treatment plant was made using the measures of effectiveness already discussed. Table 7.7.1 shows the analysis carried out using these measures of effectiveness. In the event a mix of pulverisation with some transfer of wastes to landfill sites was chosen. Officers indicated that the sequence of argument preceded as follows:

(1) The cost criterion pointed to the desirability of a system emphasising direct haul of waste to landfill sites.

(2) Shortage of landfill capacity precluded a pure direct haul system and enforced the inclusion of pre-treatment or transfer.

(3) The need for flexibility argued for mixing technologies.

(4) Transfer by rail was selected on cost and environmental grounds. Reduced traffic flow was the environmental issue mentioned.

(5) Wet pulverisation was selected on grounds of cost, its resource providing nature and flexibility. Resource providing nature and flexibility were seen as linked. The system was thought capable of producing a variety of types of raw material. Figure 7.7.1 shows the three possible types of output.

(6) High density baling was seen as possibly a relatively cheap, reliable back-up technology, and was therefore

TABLE 7.7.1

COMPARATIVE SUMMARY OF TREATMENT OPTIONS (COUNTY 'F')

OPTION	A		B	C	CRITERIA D	E	F	REMARKS
	Capital Cost per tonne/day installed capacity		Total disposal cost/ tonne excl. residuals transport	Plant construction time	Bulk reduction Residual Volume including cover needed (if any) as %	Residuals Quality when used as landfill	Reliability	
	Normal	24 hour use						
HIGH DENSITY BALING	£8500	£4250	£10.5	33 months	37% requires cover	Relatively inoffensive but attracts birds	Fairly good, but only single stream plant	
WET PULVERISATION	£8100	£5400	£10.1	37 months	47% no cover required	Inoffensive	Good Two stream plant	Residuals may have other uses as either fuel or feedstock for further processes
COMPACTION	£6000	£4000	£12.9	33 months	94% requires cover	Nature of refuse unchanged	Good, multi-stream plant	Really only a clean convenient transport method
INCINERATION NON-RECUPERATIVE	£15000	£15000	£16	45 months	25%	Inert	Poor, but two stream plant	
INCINERATION RECUPERATIVE	£20000	£20000	£17	74 months	22%	Inert	Fairly good because of heat recovery unit 2 stream plant	

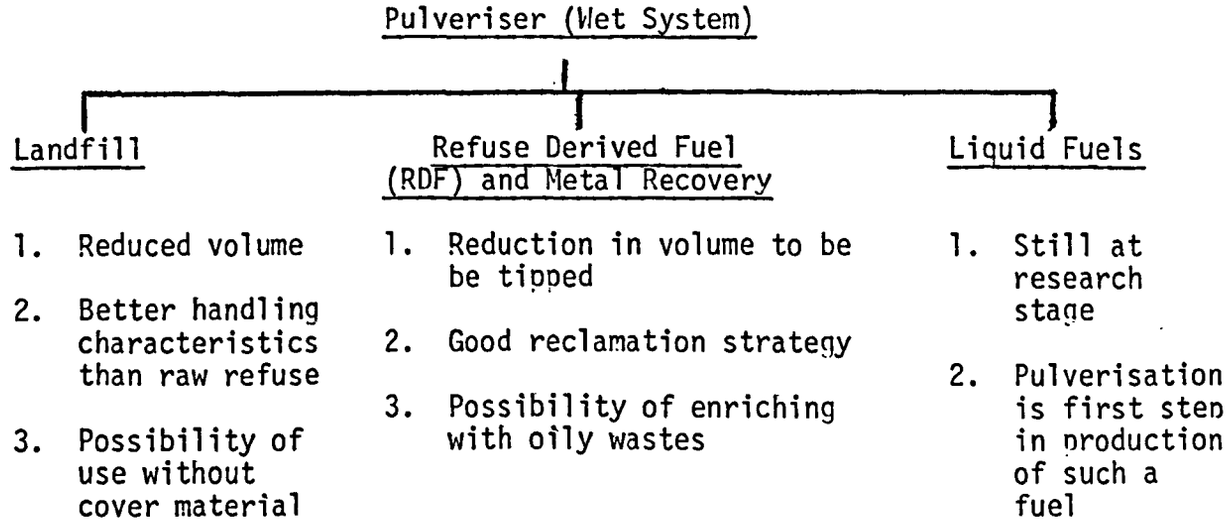


Figure 7.7.1: "Possible Material Outputs from Wet Pulverisation"

identified as a possible element in the technology mix.

Substantial testing of the refuse derived fuel output of the pulverisation process was carried out by the county in developing stage (5) of the above argument. Further, officers indicated that research into enhancing fuel quality and production of a liquid fuel had been commissioned. Some research activity was said still to be going on.

Officers indicated that although technology choice was a key element in a strategy, it was not the only element. They indicated that collaboration with the private sector was also an element in the county's strategy. One aspect of this cooperation was an attempt to increase the potential market for the refuse derived fuel by:

(1) Making a joint approach to potential customers in association with a specialist energy company.

(2) Encouraging potential customers to invest in suitable combustion equipment by putting them in touch with sources of finance.

A second aspect of this cooperation was an attempt to affect waste generation at source by advising firms on ways of preventing waste or of using waste. Officers indicated that they hoped that the industrial waste survey would assist them in this task. A final attempt at cooperation was said to involve encouraging private contractors to develop the capacity to cope with difficult wastes.

g) Alternative Generation, Evaluation and Selection

Officers indicated that this activity was limited. They stated that strategy evaluation gave considerable guidance as to what had to be done and that considerations of feasibility then took over. The issue appeared to be not how to choose but rather whether a single alternative was available. Officers indicated that feasibility was capable of commonsense interpretation. On being asked about cost calculations, officers stated that the estimates of capital cost and typical revenue cost used at the strategy evaluation stage were generally sufficient. They stated that discounted cash flow was not a mechanism in use.

h) Monitoring Implementation

Officers stated that there had been problems in the past, particularly with regard to acquiring landfill sites. Some of these problems related to the requirements of the water authority. However, officers were quick to stress that relations between county and water authority were amicable, and that the water authority was willing to consider compromise solutions when problems occurred. Officers indicated that more important factors than the role of the water authority were public hostility, and the speed with which planning permissions were obtained. Officers stated that public hostility to landfill had continued despite improvements in the standards of tipping. They hoped that pretreatment of refuse to reduce its offensiveness and the implementation of a public consultation process about acquisition of a landfill site in advance

of a planning application would improve the situation. However they held out little hope that landfill availability would increase.

Officers felt that the inability to complete the landfill site acquisition process speedily would have increasingly severe consequences in the future. They indicated they were in a dilemma about their attitude to industrial and commercial waste; if they continued to accept it they would run out of capacity, while if they encouraged the private sector to take over the function they might lose out in the race to acquire landfill sites and therefore run out of capacity! Officers felt they might not be able to compete with private contractors either in ability to operate at speed or in ability to pay.

Officers were asked about relationships with districts. They indicated that one district in particular was antagonistic towards county activities and was seeking to gain support for the view that the disposal function should return to the districts. County officers however felt that this view was not shared by the other districts.

As far as the switch to pre-treatment went, officers indicated that it was too early for any implementation problems to become apparent. However officers did acknowledge that other counties had had problems with incineration.

i) Interviewer's Evaluation

Officers in this county appeared to have taken a forward look, and

to be attempting to build up a desirable waste disposal system. They appeared to be doing more than simply making ad hoc responses to current problems. However, that having been said, there has to be some doubt about the nature of the desired future. The claim that refuse is viewed as a resource may be true, but the absence of any attempt to measure resource use counts against that view. It is possible that cost is the main issue and that the willingness to look at reclamation rather than just disposal stems from the high cost of the disposal system which was inherited when local government reorganisation occurred. This view likens county F to county E.

Whatever the objective which underpins the analysis activity in county F, the activity itself appears to have much in common with rational planning. The description which officers offered of the way in which strategy evaluation took place supports this view. As Faludi (1973, p.36) points out, even if the account is a biased reconstruction, it demonstrates a need on the part of officers to show that their arguments are consistent with a rational evaluation process.

It is interesting to note that once again officers are concerned with developing a flexible system, one which can cope with whatever the future may bring. In this particular county the road to flexibility is seen as involving a mix of technologies.

7.8 County 'G'[9]

a) Background

On local government reorganisation, this metropolitan county inherited a disposal system consisting of incinerators and landfill. The theoretical capacity of the incinerators was sufficient to cope with nearly all of the waste arising in the county in 1980. However, despite the fact that all the incinerators were still in use, only about 50% of waste was incinerated in that year. The rest went untreated to landfill, either directly, or via one of two road transfer stations. The fact that the incinerators dealt with only 50% of waste was due to the fact that at any one time several incinerator streams were typically out of action to allow maintenance of some kind. Surprisingly, the older incinerators were the least troublesome. The landfill capacity which was inherited was spread over many small sites. By 1980 many of these sites had closed and those remaining were close to the end of their useful lives.

b) Existence of a Planning Activity

This county was the only one among the seven counties contacted during the interview stage of the research to have produced a draft of the waste disposal plan which they intended to send to the D.O.E. However the thrust of the document was the justification of a suggested strategy rather than the exploration of strategic options. Officers in the waste disposal group indicated that they saw planning as a valuable activity and that they did plan. However, discussions

indicated that the planning activity was relatively short term and had much in common with 'blueprint planning'. That is to say planning centred on the production of a plan which was then to be implemented without any attempt to revise it in the face of changed circumstances.

The personnel involved in the planning activity included some from other county departments, since county G operated a corporate working system. Within the county there were seven officer working groups, including one which dealt exclusively with waste disposal matters. This group typically met once a month. Any document which it approved was sent to a Chief Officers Group for discussion. If passed there, the document went on to the relevant committee of council. If it was not passed on to council the document went back to the original working group. The aim of the corporate working system was to stop departments proceeding in isolation. It was hoped that departmental conflicts would be identified and reconciled long before a proposal received council attention.

The relatively late appearance of councillors in the corporate working process deserves note. Officers argued that this was inevitable given the restricted amount of time councillors had available. They argued that the best a councillor could hope to do was get a 'feel' for a proposal. It was felt he could not be expected to get to grips with details. On being asked, officers indicated that they initiated policy and that councillors improsed their own political slant on it. Discussions with councillors indicated that although they did not question the appropriateness of their late appearance in the planning

process, they had strong views about the quality of the material provided for them on waste disposal issues. Councillors stated that they distrusted the quality of the analyses produced by waste disposal staff and were dubious about the ability of staff to put plans into action.

c) Problem Definition

Officers indicated that their aim was to ensure least possible cost disposal of waste, having regard to environmental consequences. However they indicated that they had in the past carried out significant materials recycling and energy recovery activities and hoped to continue to do so in the future. Officers stated that the interest in recycling did not involve them in technology development. Officers indicated that they defined costs and benefits in a narrow fashion. Social benefits were seen as the responsibility of the national government. It should be noted that the above statements were supported by the contents of the draft waste disposal plan.

d) Measures of Effectiveness

Officers did not offer any information about measures of effectiveness directly. It appeared that in many cases relevant measures were defined when a problem of evaluation arose. However, examination of the draft waste disposal plan reinforced the view that cost was an important criterion. However the components of relevant cost were not explicitly defined. A review of other written material suggested that cost figures were made up in different ways for different projects. This may simply have reflected a view that for some projects certain costs were not material, but this was not clearly the case.

It was noted earlier that officers defined community in a relatively narrow sense. They indicated that some costs and benefits were the province of national government rather than local government. During discussion it became clear that the relevant community was not even the county in its widest sense. It appeared to be the county as opposed to the districts. Two comments in particular served to emphasise this point. Firstly officers indicated that a suggestion had been made that district reclamation activities should be financed in part from any savings in disposal costs which stemmed from the reduced waste flow. Councillors agreed with the view, supported by officers, that the proposal should be rejected. Secondly, a senior officer stated that a disposal decision which reduced the aggregate of county disposal and district collection costs, but which increased the county disposal cost, would not be considered.

It was not possible to find any information about which types of environmental effect were generally regarded as important. Again concerns seemed to be specific to situations.

e) Forecasting

Officers indicated that data on domestic waste quantities had been collected by districts for several years. They also stated that the district covering the major urban area in the county carried out a waste composition survey on an annual basis. Officers further indicated that a survey of industrial wastes had been carried out and that similar follow up exercises were planned for the future.

This history of data collection activity enabled officers to make informed statements about the quantity of waste being produced in the county. In the case of industrial waste in particular, attention had been given to generating a statistical confidence interval around the central estimate. The availability of data had also allowed academics at a local university to produce short-term forecasts of waste quantity and composition.

The availability of data and an association with statistical forecasting exercises had not generated a substantial forecasting exercise within the county waste disposal group. Officers identified three factors which they felt affected waste quantity: number of households, size of population and level of economic activity. Officers indicated that in the light of these factors and given available national statistics on quantity of waste, they were allowing for a 1% growth in waste per annum over a ten year time horizon. In one conversation an officer indicated that 75% of this growth was seen as stemming from an increase in the number of households, and 25% from increasing affluence. No further information on the forecasting exercise was made available. However it was apparent that despite the availability of a relatively large database, it had been subjective in nature.

As far as waste composition was concerned the waste disposal group produced no internal forecasts. There were however forecasts available for other waste related items, for example, available landfill capacity. The basic data underpinning this forecast was an aerial survey of the county.

During the course of discussions with county G the author was invited to comment on an analysis of a metal recovery project which was being carried out. The author pointed out the economics of the project would be affected by the future course of scrap metal prices, and county officers expressed an interest in getting access to forecasts of such prices. However on being told that such forecasts would be subject to a margin of error they indicated that they might not be able to use such imprecise figures in their analysis. The author investigated the availability of scrap metal price forecasts. However it became clear that if a forecast was presented, too much attention would focus on a central estimate. The author suggested that the metal recovery project should be analysed in such a way that some minimum scrap metal price needed for economic viability could be identified and discussed. However this suggestion was not taken up.

Overall officers did not appear to understand the conditional nature of a forecast and the degree of imprecision present. Furthermore little attention was paid to the way in which forecasts were produced. This was despite the fact that the draft waste disposal plan emphasised the importance of producing realistic forecasts.

f) Strategy Generation, Evaluation and Choice

Officers in the waste disposal group claimed that they had evaluated a wide range of methods of dealing with waste. However considerations of cost and the need to maintain flexibility led to a continuation of the existing mix of incineration and landfill. The two arguments appear to have reinforced each other. It was argued that flexibility

could be maintained by avoiding capital expenditure. These arguments and these conclusions featured in both the county structure plan and the draft waste disposal plan.

Councillors did not appear to have been closely involved with this strategy evaluation. However, a perceived preference for employment of direct labour as against sub-contracting to private enterprise, on the part of councillors, may have coloured the analysis carried out by officers. The exclusion of councillors from the strategy evaluation process proved to have serious consequences. Councillors effectively overturned the suggested strategy, insisting on closing down two incinerators and shipping waste to a landfill site run by a private contractor. Officers were totally unprepared for this eventuality. Incinerator closure had been seen as a long term possibility only.

g) Alternative Generation, Evaluation and Choice

Officers indicated that an aerial survey assisted them in identifying possible landfill sites. They also pointed out that although there was a landfill shortage in the short term, the situation looked likely to improve. Evaluation of potential sites seemed rudimentary. Officers indicated that water supply issues were looked at but initially little else seemed to be considered.

When it came to investigations of specific plant developments, officers were able to point to quite detailed economic analyses. Discounted cash flow exercises had been carried out, and experience in using L.P. models had been gained with the help of a local university. However

during discussions there were indications that these methods were not being applied correctly. Often, too little emphasis was placed on the imprecision inherent in much of the cost data which underpinned the exercises, and irrelevant cost elements tended to be introduced into calculations. For example one officer indicated that because interest payments on debt used to finance the incinerators were high, "it made sense" to make maximum possible use of incinerators!

h) Monitoring Implementation

Officers indicated that they recognised the need to monitor implementation. The draft waste disposal plan contained statements which confirmed this. Officers indicated that in the past, they had experienced difficulties in acquiring landfill sites. They attributed these difficulties to:

(1) Poor relations between the waste disposal group and the planning department.

(2) Difficulties in competing with the private sector for tipping space.

Officers stated that the planning department had doubts about the extent to which a landfill site could be operated in an acceptable fashion. The waste disposal group were unable to offer a well-managed site for inspection within the county, and therefore it was difficult to change this view. There was another source of friction between the waste disposal group and the planning department identified by officers.

This was the fact that the two groups had different objectives. Officers indicated that the waste disposal group wanted large sites with long operating lives, and also a reserve of sites for future use. They stated that this conflicted with the planning department's aim of turning holes in the ground into useable land as soon as possible.

As far as competition with the private sector was concerned, officers indicated that this had led to rising prices for void. They also indicated that because of an inability to react quickly, the council had failed to obtain sites. Officers stated that the publication of the draft waste disposal plan had aggrevated their problems. This document had identified the county's need for landfill space and had specified which sites county officers were interested in obtaining. Owners of potential sites had therefore been made aware that they owned a valuable asset and consequently officers had found that negotiations had become more difficult. Officers indicated that councillors had recently sanctioned the use of compulsory purchase orders on selected sites. They stated that this, together with a less open approach in future planning documents, would help site acquisition in the future.

Officers identified two other types of implementation problem. Firstly they pointed to the activities of environmental pressure groups. Secondly they indicated that district decisions could have an impact. Officers recalled that a district had switched from a paper to a plastic sack collection system without informing county officers, and that the shift in waste composition had affected incinerator performance.

i) Interviewer Evaluation

County G offered some curious contrasts. Officers emphasised their commitment to planning; a draft plan had already been produced. A committee structure was evident through which proposals passed before going to council and there was documentary evidence to show that economic evaluations accompanied these proposals. Despite all this, the author felt that although the form of an analysis/planning activity was present, the content did not match the claims made for it by officers. The planning document itself seemed more a justification of past decisions than an attempt to find alternatives. Further more there was a lack of a definition ofmeasures of performance. This appeared to lead firstly to an emphasis on some cost measure, but also to the use of inconsistent measures at different times. For example, a report on one proposal to recover non-ferrous metal from the waste stream emphasised that although a plant could not operate commercially from the county's point of view, there would be benefits to the region as a whole. The conservation of raw materials was also stressed. A report on another proposal, to recover ferrous metals, stated that there was no financial benefit to the county council and considered no other issues. The approaches taken to the identification of relevant costs and benefits were totally dissimilar in the two studies. Finally, although county officers emphasised the fact that economic evaluations were carried out, the evaluations were sometimes either incorrectly or naively carried out.

Notes

1. The material in this chapter is based on interviews carried out by the author and Mrs Mitchell. It may later form the basis of a joint publication with Mrs Mitchell. At the present however the views expressed are the responsibility of the present author alone.

2. The author acknowledges that his decision not to identify interview participants and counties by name may cause problems to a reader. Therefore the author is willing to provide necessary identification to bona fide researchers provided that guanrantees of no further disclosure are given.

3. This material was derived in part from transcripts of taped interviews with two officers. Officers also completed and returned a short questionnaire. The questionnaire was administered after the officers had read Berry and Mitchell (1980).

4. This material was derived in part from transcripts of taped interviews with two officers. Officers also completed and returned a short questionnaire. The questionnaire was administered after the officers had read Berry and Mitchell (1980). The 1975 annual report to the Planning and Transport Committee was also examined, as was a 1979 report to the Waste Disposal Sub-Committee.

5. This material was derived in part from transcripts of taped interviews with two officers. The brief circulated to consultancy groups, together with the letter asking them to prepare a proposal for production of the county waste disposal plan, were also consulted.

6. This material was derived in part from transcripts of taped interviews with officers. Officers also completed and returned a short questionnaire. The questionnaire was administered after the officers had read Berry and Mitchell (1980).

7. This material was derived from transcripts of taped interviews with two officers, in the main. Publicity material dealing with the new reclamation plant was also examined, as were extracts from a variety of internal documents.

8. The material was derived in part from transcripts of taped interviews with one officer. Discussion of specific points involved contact with several others. However the tape recorder was not used extensively during these discussions, although written notes were taken. Reports to the Refuse Disposal Committee (Oct 1979; Dec 1979) were examined, as were the relevant sections of the County Structure Plan.

9. This material was derived in part from transcripts of taped interviews with one officer and three councillors. Discussions with other officers also took place but the tape recorder was not used extensively, although written notes were taken.

Several committee reports were referred to: Waste Disposal Corporate Group (1979, 1980), Waste Disposal Committee (1980), and Policy and Priorities Committee (1980). Other documents used included the County Structure Plan and the Draft Waste Disposal Plan.

8.0 THE LANCASHIRE FIELD STUDY

8.1 Introduction

a) Job Definition

In 1976 the author was asked by Lancashire County Council and the Department of the Environment (D.O.E.) to examine a problem which faced the county waste disposal group. This was a problem of limited waste disposal capacity in the Fylde Coast region of the county. The Midgeland Farm landfill site which disposed of Blackpool's waste was thought to be close to the end of its useful working life and new disposal facilities were proving hard to find.

Initial meetings with officers from the D.O.E. and the county indicated that this was not seen as a one off situation, but rather as the kind of problem which would appear in the future in other areas of Lancashire and in other counties. Therefore it was decided that although help was required with the Fylde Coast problem in particular the approach adopted should be generally applicable.

b) The Organisational Arrangements in Lancashire

Lancashire's waste disposal group was located in the County Surveyor's department under the control of an Assistant County Surveyor. In 1976, the group was divided into three sections, the operations section, the development section and the industrial waste section. In 1976 the operations section was not yet fully functional. It was intended that

at some point, the section would take over the operation of all landfill sites within the county. However at that time, agency arrangements were being operated with certain districts so that district employees operated the sites and county employees gave advice. The development group was involved in providing civil engineering advice to the waste disposal team. It was also seen as the channel through which new approaches to waste disposal management would pass into the county operation. The industrial waste section had responsibility for the county industrial waste survey and for the supervision of toxic wastes.

Initial investigations in Lancashire showed that the county waste disposal group appeared to be cut off by its organisational position from crucial information flows. In part this was due to the, then quite recent, division of waste management responsibilities between counties and districts. Data on quantities of domestic waste were being collected, if at all, by the districts, as were data on collection costs. However shared responsibilities with other groups within the county structure also appeared to be a factor. Chief among these other groups was the Vehicle and Plant Maintenance Unit (V.P.M.U.). The V.P.M.U. was also located within the County Surveyor's department. Its role was to provide vehicles for all county operations including those of the waste disposal group. The waste disposal group had reached an agreement with the V.P.M.U. that if a proposed job was adequately specified, e.g. transfer 400 tonnes of waste for 25 miles, the V.P.M.U. would provide estimated job costs. However problems seemed to exist. Although the choice of a vehicle to serve the waste disposal group was the province of the V.P.M.U., the choice of the

equipment the vehicle would carry was the province of the waste disposal group. The interaction between these choices seemed to have generated conflict in the past. It appeared difficult for the waste disposal group to adequately specify a job without trespassing on the responsibilities of the V.P.M.U. Furthermore, the waste disposal group needed cost data in order to decide how much waste to send along a particular route, while the V.P.M.U. felt that it needed to know the amount of waste to be transported before it could carry out a cost calculation.

During discussions, officers in the waste disposal group indicated that while they recognised that relations with the V.P.M.U. were a problem, they felt that the county/district split was not so important. They acknowledged that district data had not been available in the past but felt that specific requests for districts' data would bear fruit.

c) The Fylde Coast Problem

As was stated earlier, by 1976, Midgeland Farm, the landfill site which accepted waste from Blackpool appeared close to the end of its working life. Without extension, the site seemed likely to last for only two more years. Furthermore, because a new road bringing tourists to Blackpool was planned to pass close to the site, it was felt that permission to extend the site might not be easily obtained. For this reason, the waste disposal group had attempted to identify potential new landfill sites in the Blackpool area, but such sites had proved difficult to find. In 1976, there appeared to be only two rather remote possibilities. In one case, a current industrial user had

indicated an unwillingness to make the site available to the county, and in the other case water pollution problems and the need to encroach on prime agricultural land seemed likely to be major problems.

Because of the problems of developing new sites, the waste disposal group decided to explore several options. Firstly they decided to maintain an interest in the potential new sites, secondly they decided to explore further the possibility of extending Midgeland Farm and finally they decided to explore the possibility of hauling waste out away from Blackpool via a transfer station. It was this final option which the waste disposal group wanted assistance in analysing. The arguments for carrying out an analysis of the transfer option were twofold, firstly that a transfer station might have to be operated and secondly that if such an operation was shown to be very costly, this would strengthen the case for extending Midgeland Farm.

The possible need for a transfer station stemmed from the fact that direct haul of waste out of the area in collection vehicles was likely to be prohibitively expensive. There were two possible locations for waste from Blackpool to be transported to. The Jameson Road site, located in the Northern part of the Fylde Coast on the banks of the River Wyre, was feasible. The existing site had considerable capacity, and with extension had a potential life of several decades. The other alternative was the Clifton Marsh site. Located in the South of the region on the banks of the River Ribble, this site also had a potential life of several decades. However both sites were a relatively long way from Blackpool. Therefore the waste disposal group felt that hauling Blackpool's waste to either site would need a transfer station, a

facility at which collection vehicles could be unloaded and the rubbish transferred to more economical bulk haulage vehicles. Officers felt that bulk reduction might also take place at this facility.

Officers regarded this transfer station option as a second best to landfill on environmental grounds and likely to be costly. They also saw it as difficult to analyse. They wanted to know where a transfer station should be located, how much waste should go through it and from which part of Blackpool should the waste come.

8.2 The Characteristics of the Fylde Coast Problem

a) Geography

In order to develop an approach to analysing the Fylde Coast problem, the structure of the region was examined. Blackpool was one of three districts on the Fylde Coast. The others were Wyre in the North and Fylde in the South. Wyre was split into a coastal section and an inland section by the River Wyre. In 1976, waste from the coastal section went into Jameson Road. The waste was transported to the landfill site in collection vehicles. Therefore a transfer station located in the North of the Fylde Coast region was of potential use not only to Blackpool but also to some part of the Wyre coastal strip. The inland area of Wyre, Over Wyre as it was known, sent its waste to a variety of landfill sites in the inland region. The difficulty of transporting waste across the Wyre removed the possibility of Over Wyre benefiting from a transfer station in the Blackpool area. The waste generated in the Fylde district went either to Clifton Marsh or to an incinerator in Lytham. The Residue from the incinerator went to a small landfill site. The Lancashire waste disposal group indicated that the incinerator was coming to the end of its useful life and could be disregarded in the analysis of the Fylde Coast problem. However since without benefit of incineration the small landfill site associated with it would quickly fill up, the waste then going to the incinerator had to be coped with by any haul and transfer system.

b) The Collection of Refuse

After the 1974 reorganisation of local government areas and responsibilities, districts continued to be responsible for the collection of

refuse generated in their area. This waste included domestic refuse collected by bins, street sweepings, rubbish from large buildings collected by bin lift, and special collection waste. This last category included bulky domestic waste which could not be fitted in bins. Districts provided special sites to which householders could deliver such bulky refuse, or sent out a special vehicle on request. Districts were not responsible for the collection of industrial and commercial waste. However this could be tipped at county sites on payment of a fee.

In 1976, ordinary domestic refuse was the major item which the districts on the Fylde Coast had to deal with. The collection of this waste was organised on the basis of collection rounds. Each district divided its area up into a number of rounds and assigned a collection team and a vehicle to each round. In the Blackpool district the rounds were such that one collection crew with one vehicle could deal with the waste generated in the round in a week. The wishes of the collection teams were taken into account when the areas were designed so that a team willing to work longer hours in order to collect a larger bonus was given a larger collection round. Because of the influx of holidaymakers in the summer months, Blackpool's refuse exhibited highly seasonal variations in its amount . For this reason, in the late summer period the simple rule of one vehicle to one round broke down. On certain rounds extra vehicles had to be assigned.

The other waste elements which the districts collected were not collected on a round basis. For each type of waste a vehicle covered all or a large part of the district's area.

A typical day in the life of one of Blackpool's domestic refuse collection teams had the following pattern. At 6.40 a.m. the driver arrived at the depot where his vehicle was garaged. He checked the vehicle and then left the garage in it to pick up his four man collection crew at pre-arranged spots. The first dustbin was lifted at 7.00 a.m. Roughly by 9.00 a.m. the collection vehicle was full. The typical collection vehicle held approximately 4 tonnes. The driver took the vehicle to a landfill site (then Midgeland Farm) and emptied it. He was generally accompanied by one of the collection crew to assist him in this. The other members of the collection crew were allowed to roll out bins from houses while they were waiting for the vehicle to return. Collection continued until 12.00 a.m. when the collection crew took an hour long lunch break. The driver's lunch break was 30 minutes long to allow for another trip to the landfill site. After lunch, collection continued and a final trip to the tip was made. The driver then returned the vehicle to the depot. His working day finished officially at 4.40 p.m.

The Blackpool area was split into 19 collection rounds. Round 19 was split into three distinct areas. Fylde had five rounds in the urban part of the district and six in the inland rural area. Again the split round phenomenon was evident. The coastal region of Wyre had three rounds in the Fleetwood region, three in the Thornton Clevelys region and two in the Poulton region. Again some of the rounds were split. The general geography of the area, and all these collection rounds, are shown in Figure 8.2.1.

According to the county waste disposal group, possible transfer site

locations in the Blackpool region were few and far between. The nature of the operation and in particular the volume of traffic generated made it impossible to locate close to housing. The fact that the Fylde Coast was a tourist area also imposed restrictions on possible sites. A preliminary search by staff of the waste disposal group identified three possible sites. To confirm the suitability and availability of these sites was likely to be a time-consuming exercise so it had been decided that the analysis of the Fylde Coast problem would be used to determine which of the possible sites would be subjected to further analysis. The three possible sites, together with the landfill sites, Jameson Road and Clifton Marsh, are shown in Figure 8.2.1.

PULLOUT

FIGURE 8.2.1.

The Fylde Coast Area.

B1-B19 Blackpool Collection Rounds.
W1-W5 Wyre Collection Rounds.
P1-P2 Poulton Collection Rounds.
F20-F26 Fylde Urban Rounds.
Named Areas Fylde Rural Rounds.

⊗ Transfer Stations. Landfill Sites.

8.3 A Mathematical Model of the Fylde Coast Problem

a) From Map to Model

The detail about round organisation shown in Figure 8.2.1 came from a series of meetings between the author and officers in the three Fylde Coast districts. These meetings were time-consuming, but yielded valuable results. Among other things they seemed to generate a degree of goodwill among county and district staff towards the research project; district officers felt that their interests were being taken into account, and county staff, who had at that time only limited knowledge of district operations, saw the map as a valuable initial output of the research effort.

However the major value of the map was that it suggested an approach to modelling the Fylde Coast problem. Although the map itself was a dramatic simplification of reality, it was still a relatively complex representation of the problem. Further simplification to the level shown in Figure 8.2.2 was necessary to identify the key problem elements. This figure shows that there were a large number of points at which waste arose, three possible locations where waste could be treated (even if this treatment only involved moving waste from one vehicle to another) and two possible final destinations for waste. The progression from the left hand side of the figure is from many waste sources to few waste destinations. The lines indicate possible routes along which waste can travel from a source point to a final destination. Some lines pass through intermediate treatment facilities, some do not. The form of Figure 8.2.2 clearly indicated

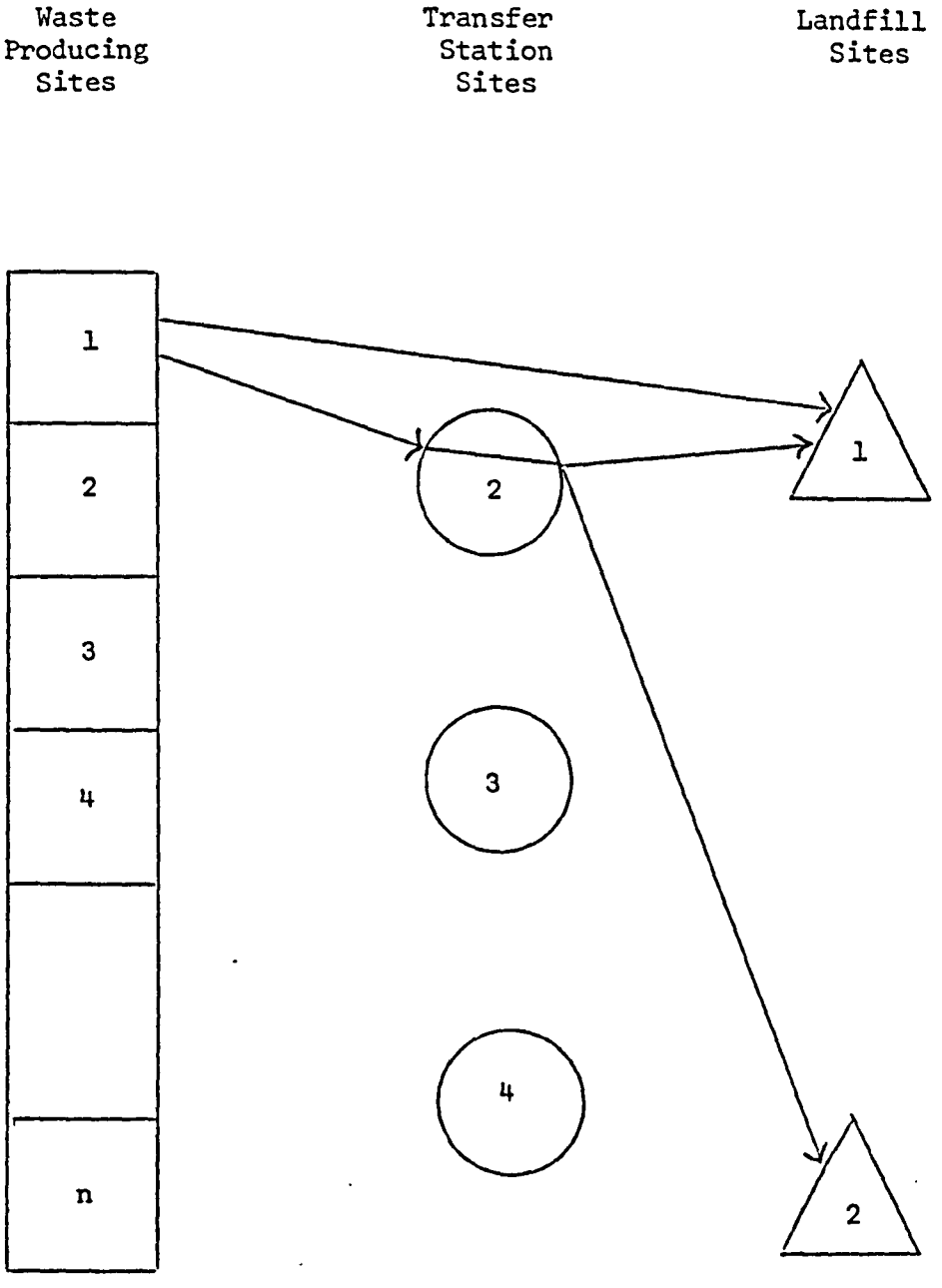


Figure 8.2.2

A Simple Representation of the Blackpool Problem

that a mathematical programming model similar in structure to a transportation model would be a useful starting point for mathematical modelling. Therefore a mathematical program was formulated to allow for the selection of the least costly collection/disposal system given that several pre-specified alternative transfer station locations were available. This formulation was used as a basis for discussion with waste disposal group members.

b) The Initial Mathematical Programming Model

A mathematical program has several key elements. It is a representation of a problem which emphasises that some item can be viewed as being maximised or minimised. This item is expressed as a function of certain decision variables. An example of such an "objective function" would be profit expressed as a function of the amount of various types of product produced. In a mathematical program, the objective function is optimised subject to certain restrictions or constraints. In a profit maximisation problem, for example, raw materials needed to make the products which generate profit might be in short supply. This profit maximisation example can be used to introduce another key element of a mathematical program: the decision variables can only take on non-negative values. It makes little sense to talk about producing a negative amount of a product, and this non-negativity characteristic of decision variables can be found in many kinds of economic problem.

How did the Fylde Coast problem fit into this general framework? Firstly, there appeared to be a clearly identified objective,

minimisation of the total cost of the waste disposal/collection operation. Secondly, there were a series of decision variables which related to the total cost of the collection/disposal system, namely the number of transfer stations built and the amounts of waste sent along the various routes. Finally there were a number of constraints, all waste had to be dealt with, only a certain number of transfer stations could be used, and their capacity could not be exceeded.

The form of the objective function and the nature of the decision variables will now be considered in more detail. It was decided to emphasise cost minimisation in the objective function. This choice reflected the importance which the waste disposal group assigned to this performance measure. The choice did not imply that other factors, for example environmental impact, were ignored. It has to be remembered that environmental factors had governed the selection of possible transfer station sites and also had partly determined the second best status of a solution involving a transfer station. However it did mean that the way that environmental factors were calculated and valued was left implicit rather than being explicitely introduced to generate a multi-objective mathematical program. It was decided that the way in which non cost factors were being treated could be discussed when the initial model was presented to the waste disposal group for consideration.

It was indicated earlier that the cost of a collection/disposal system depended on the amounts of waste to be sent along the various routes and the number of transfer stations involved. From Figure 8.2.2 it can be seen that all conceivable routes started at a waste source

and ended at a landfill site. However some had a transfer station as an intermediate point. In order that all routes had the same form for modelling purposes a dummy transfer station was defined with an infinite capacity which all routes not involving an actual transfer station could be thought of as passing through. In this way it was possible to identify all possible routes by three numbers (i,j,k), where i = 1 ... n represented the waste source, j = 1,2,3,4 the transfer station (1 being the dummy), and k = 1,2 the final landfill site. Using this notation, a major element of the objective function was defined as:

$$TC = \sum_{ijk}\sum\sum c(i,j,k).x\ (i,j,k)$$

In this equation x(i,j,k) represents the number of units of waste transported along route (i,j,k) and c(i,j,k) the cost of transporting one unit along the route. TC of course represents total cost. The nature of c(i,j,k) will be discussed shortly.

A major element missing from this cost function is an element dealing with the investment involved in developing a transfer station. Each transfer station was therefore associated with a decision variable d(j) which was defined as capable of taking on only two values, 0 or 1. d(j) = 1 was defined as meaning that the transfer station had to be built. Using these variables and identifying the investment cost of a transfer station as C(j), the objective function was extended to become:

$$TC = \sum_{j} C(j).d(j) + \sum_{ijk}\sum\sum c(i,j,k).x\ (i,j,k)$$

Discussions with the waste disposal group indicated that a transfer station at any of the feasible locations would involve the same investment. Therefore identifying a cost element for each transfer station was only necessary because C(1) = 0 by definition.

The nature of the cost elements C(j), c(i,j,k) will now be examined. The first thing to note is that the cost elements have a time dimension. The investment in transfer stations was a planned once-off cost. However waste would flow along routes in many successive time periods. Therefore it was recognised that when building the model rather than just specifying its general form, waste flow variables x(i,j,k) and cost elements c(i,j,k) would have to be defined for each time period. This makes obvious the fact that the cost elements c(i,j,k) had to be defined as discounted costs to ensure that the elements in the objective function were comparable. The second thing to notice is that the cost elements c(i,j,k) related to several operations, collection, haul in a collection vehicle, transfer, haul in a bulk haulage vehicle, and final tipping. The use of a single cost element also implied that all these operating costs were strictly proportional to the amount of waste being dealt with. That is to say total operating costs were being represented as a zero intercept, linear function of the amount of waste shifted.

It was decided that the possible complexities of model structure which explicit recognition of the complex nature of these cost elements would involve would not help the waste disposal group to understand the basic nature of the proposed model. Therefore the initial

formulation of the mathematical programming model kept the simple objective function:

$$TC = \sum_{j} C(j).d(j) + \sum_{ijk} \sum \sum c(i,j,k).x(i,j,k)$$

The form of the various constraints in the mathematical program will now be considered. Paramount among these was the need to ensure that all the refuse generated in the Fylde Coast region was disposed of. In order to translate this requirement into a mathematical form, the Fylde Coast region was divided into a set of non-overlapping areas. The grid of an ordinance survey map would define such a set as would the set of refuse collection rounds. It was decided to regard the waste generated on the Fylde Coast as being generated at the set of points defined by the centres of these areas. These central points also defined the starts of all the routes implied by Figure 8.2.2 This allocation of waste to points was of course yet another abstraction from reality. The extent of the abstraction depended on the fineness of the grid pattern actually used in a model building exercise however. To define the constraints for the mathematical program, variables W(i), the amount of waste arising at waste source i per time period where i = 1 ... n, were defined. The constraints then demanded that the sum of the waste leaving source i along all possible routes must be equal to W(i) for all i:

$$\sum_{jk} \sum x(i,j,k) = W(i) \qquad i = 1 \ldots n$$

A second constraint which had to be taken into account was that of transfer station capacity. Coefficients M(j) were defined to represent

this amount. The constraints demanded that the sum of the waste entering a transfer station along all possible routes should be less than or equal to its per period capacity:

$$\sum_{ik}\sum x(i,j,k) \leqslant M(j) \qquad j = 2,3,4$$

No such constraint needed to be defined for transfer station 1, the dummy.

Another constraint that had to be taken into acount was that potentially only one transfer station would be built. One aspect of this was relatively simple to include. Recall that a variable d(j) was defined to take on the value 1 if a transfer station at location j had to be built, and a value of 0 otherwise. Therefore to ensure that only one transfer station was selected by the model the sum of the variables d(j) was constrained to be less than or equal to 1:

$$\sum_{j\neq 1} d(j) \leqslant 1$$

The "less than" aspect of this constraint was to allow for the fact that a cost minimising solution might not involve any transfer operations. A second aspect of the same constraint was however more difficult to represent. The model had to ensure that if, say, transfer station 2 was not part of the model solution, then no waste flow through it could be positive. The need to ensure this gave rise to the following constraint set:

$$\sum_{ik}\sum x(i,j,k) \leqslant d(j)\, M\,(j) \qquad j = 2,3,4$$

Thus a positive waste flow x(i,2,k) forced d(2) to take the value 1. Similarly d(2) = 0 forced the sum of all flows x(i,2,k) to be 0. This in turn ensured that each x(i,2,k) was equal to 0 since all decision variables in a mathematical program are non-negative.

The full mathematical programming representation of the Fylde Coast problem can now be set down:

$$\text{Minimise} \quad TC = \sum_{j} C(i).d(j) + \sum_{ijk}\sum\sum c(i,j,k).x(i,j,k) \qquad (1)$$

$$\text{Subject to:} \quad \sum_{ik}\sum x(i,j,k) \leqslant d(j)\, M(j) \quad j = 2,3,4 \qquad (2)$$

$$\sum_{jk}\sum x(i,j,k) = W(i) \quad i = 1 \ldots n \qquad (3)$$

$$d(2) + d(3) + d(4) \leqslant 1 \qquad (4)$$

$$x(i,j,k) \geqslant 0 \qquad (5)$$

$$d(j) \text{ is either 1 or 0} \qquad (6)$$

It should be noted that constraint set (2) served two purposes. Firstly it restricted flows to those routes involving existing transfer stations, including the dummy. Secondly, it served to ensure that the flow of waste through a transfer station did not exceed the planned capacity of the station.

As can be seen, the mathematical programming formulation of the Fylde Coast problem turned out to be an integer programming model. That is to say it included decision variables constrained to take on only integer values.

The above formulation of the Fylde Coast problem introduced a number of simplifying assumptions. It is useful at this point to summarise the more important ones. Firstly it was assumed that there were no capacity constraints on the final landfill sites Clifton Marsh and Jameson Road. This assumption accorded with the prevailing view of the Lancashire waste disposal group. Secondly very rigid assumptions were made about the behaviour of operating costs. Thirdly it was assumed that the amount of waste to be removed from the Fylde Coast was known. In fact the precise form of the above formulation assumed that these amounts were known and would not vary through time and that therefore the cost coefficient c(i,j,k) would be sums of discounted future costs. Without this final assumption, waste flows and cost coefficients would need a fourth parameter t, to identify the relevant time period.

c) Use of the Original Formulation

This initial formulation of the Fylde Coast problem served several purposes. Firstly, it provided a viewpoint from which the management science literature dealing with waste disposal could be examined. Secondly, it identified the type of software package which would be needed to handle the final model. Thirdly, it served as the basis for discussions with officers of the county waste disposal group. Finally, the model identified the kind of data which would be required.

A brief survey of the literature indicated that the mathematical programming approach had been quite widely used. However there

appeared to be considerable disagreement about the particular type of mathematical program to be used. This seemed to reflect different views of cost structures and different views about the detail in which the collection activity should be modelled. Overall, the literature did not seem to warrant a drastic revision of the proposed approach.

It seemed clear from the initial model that mathematical programming software might be necessary to solve whatever model was finally built. Therefore the availability of mathematical programming packages to the county authority was examined. Discussions with the Technical Services group in the county determined that a commercial mathematical programming package was available on the Lancashire computer installation, but that no one had ever had any occasion to use it. It also became clear from these discussions that the waste disposal group was not a heavy computer user.

Officers in the waste disposal group confirmed that they had made little use of the county computer facility until that time. However they pointed out that work on notifiable waste looked likely to involve them in the development with the Technical Services group of a database handling package in the near future. They indicated that a need to use the computer in the course of analysing the Fylde Coast problem was not likely to cause major difficulties. However the initial formulation of the model did cause problems. While there was broad agreement with the overall idea, the model was seen as complex and difficult to understand. This was seen as a barrier likely to prevent ease of use and also likely to prevent the group from using

the same approach again when another similar problem appeared elsewhere in the county. Ease of use seemed to be a particular problem. Further discussions indicated that the waste disposal group saw themselves as having to respond to a series of "what-if" questions while analysing and advocating a solution to the Fylde Coast problem. They saw these questions as being posed by districts and by other interested bodies such as the local water authority. The overall impression gained was that what was required was a method for assessing the cost consequences of specific alternative proposals. In particular there was no enthusiasm evident for introducing a more complex objective function. Environmental issues were seen as judgemental - something to be interpreted in the light of a public reaction.

8.4 The Data Collection Exercise[1]

a) Introduction

The initial model of the Fylde Coast problem which was built established a framework for the data collection exercise. It indicated that a collection operation, a transfer operation, a haulage operation and a tipping operation, were all involved in the process of cost generation. Consideration of the cost coefficients during the model formulation process also established that capital costs and both fixed and variable operating costs would have to be considered. It was also clear that a set of waste quantities assigned to source points was required.

Waste disposal officers indicated that in the past they had had difficulty in specifying the kind of data required for a particular problem on hand and in finding it. Therefore they viewed the initial modelling exercise as valuable if only because it helped in the specification of the data collection exercise.

b) Data on Waste Generated

During discussions, officers in the county waste disposal group indicated that they were able to produce figures for the amounts of waste produced in the districts of Blackpool, Wyre and Fylde on the basis of a tried and tested rule of thumb. This was that every 1000 of population produced 5 tonnes of waste per week. Data on the Preston area was quoted to support this rule. On this basis, it was

anticipated that in 1976, Wyre would generate 32000 tonnes of domestic refuse per year, Fylde 23000 tonnes and Blackpool 51000 tonnes. However county officers did not have available population data for the three districts on a disaggregated basis. Therefore they were only capable of identifying, in effect, three waste sources.

It was decided to contact the three districts themselves to see what data they collected. The Area Officers within the operations section of the county waste disposal group were asked to make enquiries in Fylde and Wyre. Blackpool was contacted directly by the author.

The Management Services section in Blackpool had the task of constructing new collection rounds when some change, such as a new housing estate, made this necessary. In order to construct rounds which satisfied the collection teams, they collected data on current collection operations in some detail. For the then current sets of collection rounds they had a record of the number of tonnes of waste collected per week over several years, measures of times taken from an agreed round centre to the tipping point, and records of the number of loads carried per day. Given that the rounds were constructed to allow a basic three trips to the landfill site per day, the data not surprisingly bore this out. There were two points of major significance in the comments of the Blackpool staff. Firstly, round reorganisation took the wishes of the collection crews into account. Since the old rounds generated a desired pattern of bonus payments, there was considerable pressure to ensure that new rounds

generated an equally acceptable pattern. Thus, so far as wage costs went, round reorganisation did not present much opportunity for cost reduction. Secondly, the efficiency of the Management Services section yielded results because at Midgeland Farm, the then current Blackpool tip site, there was a weighbridge. Without this, data on waste collected could only have been based on intermittent sample weighings at another site. Specimen data on weight of waste generated in the Blackpool region are given in Appendix 3. A full copy of all such data collected was provided to the county waste disposal group. The data supported the rule of thumb proposed by the county waste disposal group. Total waste generated per year for 1976 looked like being in the region of 56000 tonnes as compared to the predicted figure of 51000 tonnes.

The data situation in Fylde and Wyre did not prove so satisfactory. Each district was divided into collection rounds and maps showing these rounds were made available. However, no agreed centres seemed to exist. Further, the data on waste generated per round consisted only of specimen weighings. The weighings, though recent, could not be precisely dated. Undoubtedly, the information did exist within the district, but county staff had not been able to locate it. The data initially generated for Fylde and Wyre are also shown in Appendix 3.

Some time after a revised model of the Fylde Coast problem had been built and computer runs carried out based on this rather limited data set, the author discovered that at least in Fylde a more detailed data set was potentially available. A visit to the Lytham Incinerator

to check information on collection round areas led to the discovery that a weighbridge existed on site. Since Fylde's urban rounds sent refuse there, time series data for these rounds possible existed at the incinerator installation. County officers agreed to explore this issue. At roughly the same time a query to county officers about the number of loads of waste passing from Preston to Clifton Marsh, in connection with some cost analysis being carried out, brough to light an analysis of loads and a record of weight of waste tipped. Since Fylde's rural rounds also tipped at Clifton Marsh, by inference a similar data set possible existed for them. Again county staff agreed to pursue the issue.

The initial efforts of the author and county staff to collect data on waste quantities were then not totally successful. In terms of the number of waste sources which could be identified, it proved impossible to disaggregate the Fylde Coast area beyond the collection round level. Therefore it was decided that in any mathematical model, waste sources would be identified with the centres of these rounds. Where agreed centres did not exist, the centre of gravity of the round was estimated. Where this fell at a road junction, the road junction was used to identify the round centre. Where, as was the case in some rural areas, the centre of gravity fell away from the road network, the closest road junction was taken as representing the centre of the round. It was from these round centres that the lengths of the various routes between rounds and transfer station locations and rounds and landfill sites were measured. The problem of split collection rounds has already been mentioned. Where these occurred, the parts of the rounds were treated as separate waste sources and the waste generated figure for the round was divided between the parts on the basis of their relative areas.

The calculation of round centres by centre of gravity and the allocation of waste on the basis of the areas of parts of split rounds were crude solutions to the problem of identifying waste sources. Their only justifications were speed and simplicity. It was decided that a more sophisticated approach could wait until the waste disposal group had become model users rather than onlookers.

c) Route Distances

The cost data required for the proposed model were based on routes and the calculation of some cost elements required route distances. Collection vehicles and bulk haulage vehicles are cumbersome and relatively slow moving. Therefore operators sometimes select a route which is not the shortest distance route between two points. Advice received from county and district officers indicated that routes should deviate from major roads only where absolutely necessary. Therefore initial calculations of route distances were based on this principle.

Initially calculation of route distances seemed likely to be a time-consuming activity. County waste disposal officers suggested that each route should be travelled by car or else measured on a large scale map. However enquiries in the Technical Services department revealed the existence of a County Road Index. This document listed distances between landmarks such as roundabouts and road junctions on all "A" and "B" class roads in the county. All that was required to make use of this data source was a knowledge of the road numbers on a proposed route. The county index did not adequately cover those parts of routes

through the more urban areas, but further enquiry indicated that at least for Blackpool there was a further index constructed on the basis of named streets. For the purposes of the Fylde Coast problem then, route distances were calculated using the County Road Index, and the Blackpool Road Index. Where difficulties arose because of incomplete coverage of the two documents, Ordinance Survey Sheet 102 and a measuring wheel were used. A set of route distances is included in Appendix 3.

d) Collection Costs

It was decided on the basis of discussions with county staff that Blackpool was the district most likely to have collection cost data available. Therefore the Management Services group in that district was approached once again. This group was found to collect very detailed information about wage payments but no data on vehicle operating costs. Members of the Management Services group stated that attempts by them to calculate cost parameters for vehicle operations in the past had not been successful.

Blackpool district's Cleansing Department was then contacted. However although this group had the responsibility for operating the refuse collection service, they did not operate and maintain the vehicles. The Cleansing Department hired vehicles from the district Transport Department. Consequently, the only cost data available in the Cleansing Department were a basic vehicle hire charge and a series of total costs for previous years.

Using this information, estimates of miles travelled per year by an average collection vehicle and of the average load carried in a collection vehicle, it was possible to produce crude cost per tonne mile figures. However these were hardly satisfactory. Therefore the Cleansing Department was asked to obtain more detailed figures. However at this point a problem arose. Although it was never explicitely stated, it became apparent that staff in the Cleansing Department were unhappy about providing cost information to the county. The argument seemed to be that they were likely to have to negotiate with county officers in the near future about compensation for increased travel due to the closure of Midgeland Farm. They therefore saw the disclosure of data as potentially hampering them in negotiations.

In an attempt to circumvent this problem, the Transport Department in the district was contacted directly. Unfortunately, this did not achieve a great deal. Firstly, the cost information was collected only in aggregate terms. This practice related to the fact that the accounting system in use was designed to aid in the calculation of hire charges necessary to balance an annual budget. Secondly, the practice of providing cost information to user departments let alone to the county was not established. Therefore there was some unwillingness to begin, some difficulty in understanding what was required, and an inability to easily provide data in the required format.

The failute to gather adequate data on collection costs from the Blackpool district led to an attempt to discover other relevant sources

of information. Initial contacts with other districts indicated that the problems apparent in the Blackpool situation were common. Therefore an attempt was made to use published data on commercial vehicle operations. The primary source for commercial vehicle operating cost data was the Commercial Motors publication (Johnson, 1976). While refuse collection vehicles did not feature in tables in this publication, it was possible to identify a representative class of vehicles. These were rigid goods vehicles with a 10 tonne carrying capacity and an unladen weight of 5.5 tonnes. The cost data included in the document related to a straightforward haulage operation and therefore were not directly applicable to a refuse collection operation. However district officers confirmed that the vehicles were comparable to collection vehicles in size terms.

The attempt to collect cost data for collection vehicles therefore generated relatively little. Total annual collection costs were available as were sub-totals for maintenance, etc, kept by Blackpool's Transport Department. However the most detailed information was that culled from public sources about privately operated haulage vehicles.

e) Haulage Costs

In 1976 only a relatively short time had elapsed since local government reorganisation. Consequently, Lancashire County Council had little experience of operating disposal facilities, and therefore records of relevant costs remained scarce. As far as haulage vehicles were concerned, the county waste disposal group had available a hire charge figure provided by the Vehicle and Plant Maintenance Unit, but

little else. The VPMU was the obvious source for further information, but at that time it too suffered from a lack of suitable cost information. At that time answering even simple questions about costs required the VPMU to expend considerable effort.

As a possible way round the need to ask the VPMU to undertake a major data analysis exercise, which seemed likely to be rather lengthy, it was decided to use Commercial Motor tables once again. As with collection vehicles, it proved possible to identify in these tables a class of vehicles similar to the haulage vehicles likely to be used in refuse haulage operations. These were 8 wheel, 15 tonne tippers. To complement the data available on these vehicles, visits were made to transfer operations in Burnley and Preston. Until reorganisation, these had been run by separate local authorities. It seemed possible that data on any haulage vehicles used might have remained at the transfer stations when the county took them over. In fact cost data were available at both sites. In the case of Burnley, the data set was reasonably detailed. However the resulting total data set still left a lot to be desired.

f) Transfer Station Costs

The waste disposal group had recently carried out an exercise on transfer station costing. The unit under consideration had been similar to that which would be used in the Blackpool region if it became necessary. Therefore the associated cost data were made available for use in analysing the Fylde Coast problem. The form in which the data was provided reflected the form in which requests for

project finance had to be submitted by the waste disposal group. Capital expenditure was identified as was first year running cost. However data relating to costs in future years were not available. Since requests for funds did not have to be backed up by the results of a discounting exercise, future costs had not been examined.

8.5 Revisions of the Mathematical Model[2]

a) Conflicts Between Model and Data

The model described in section 8.3 played a large part in structuring the data collection activity which was undertaken. Despite this, the data set which became available fell far short of that needed to produce good quality parameter estimates for the model. In retrospect this might have been expected. In using a modelling approach to analyse the Fylde Coast problem, the waste disposal group was attempting to introduce a new type of management. The information system in both county and districts was unfortunately more in tune with the old style of management and therefore conflict was inevitable. Whatever the reason for the poor quality of the available data, the lack of adequate data had to be recognised when considering whether the model as originally formulated was appropriate to the task in hand.

Only in one area was there additional data to that which had been anticipated. The discussions with Blackpool staff had led to the discovery that not all waste was collected on a round by round basis. Street sweepings in particular were collected under a different system and data were available only on a district by district basis. It was decided that initial computer runs should take this waste into account by allocating it to collection rounds in proportion to the domestic waste found there. The additional waste could not be ignored since that might, for example, lead to a transfer station option being rejected because there would be insufficient waste flowing through it. However the particular method chosen to include this additional waste was only one among several which might have been used.

b) Proposed Patterns of Model Use

Discussions with the waste disposal staff had indicated that the original formulation of the model was seen as too complicated and that this might discourage frequent use. However the need to be able to run the model quickly was seen as desirable. This need was seen as stemming from the possibility that a sequence of "what if" questions posed by interested parties might have to be analysed.

c) Model Revision

The emphasis on cost which had been evident in discussions with the waste disposal group, the need to be able to run the model quickly under different assumptions, the quality of available data, and finally the need to simplify the model combined to require a revision of the model of the Fylde Coast Problem. The most fundamental revision was to split the analysis between three separate smaller models.

The first of these was a simple model designed to allow a straight-forward haulage task to be analysed and costed. This is set out below:

$$T = [W/c]^{+} \qquad (7)$$

$$n = [D/((2.h/v) + t)]^{-} \qquad (8)$$

$$m^* = [T/n]^{+} \qquad (9)$$

$$m = [m^*/5]^{+} \qquad (10)$$

$$TC = C(1).m + C(2).2.T.h + C(3).T \qquad (11)$$

where:

T	is required number of trips
W	is the amount of waste to be moved per week
c	is average vehicle capacity
D	length of driver's working day
h	halfway haul distance
v	average vehicle speed
t	average turn round time
$[]^+$	means 'smallest integer larger than x'
$[]^-$	means 'largest integer smaller than x'
C(1)	fixed cost of running a vehicle
C(2)	running cost per mile
C(3)	trip related cost
TC	total cost.

The logic of the model is simple. It is assumed that there is an amount of waste W to be moved from a point source per week. Equation (7) calculates the number of vehicle trips required to remove this waste. Equation (8) calculates the number of trips which a driver can make during a working day. Equation (9) calculates the number of working days required to remove all the waste and equation (10) calculates the number of vehicles required on the basis of a five day week. Equation (11) calculates the operating costs for the total operation. There are three cost elements. They are all cash items. C(1) is the weekly cost incurred by virtue of owning a vehicle. It includes licence fee, insurance, and the weekly wage cost of driver and crew. C(2) is a mileage related cost element. It includes petrol, oil and regular maintenance expenses. C(3) is a trip related cost. It

allows for the fact that some costs may relate to trips rather than to miles travelled.

This simple model can be used to analyse a proposed solution to the Fylde Coast problem which does not involve a transfer operation. Given that there are no constraints on the amount of waste which either Jameson Road or Clifton Marsh can take in, each collection round should send its waste to the nearest site other things being equal. Therefore for each collection round, equations (7) and (8) can be applied directly. Equations (9) and (10) could also be applied directly, but this should only be done with caution. Local knowledge could be used instead of the automatic rounding up of equations (9) and (10), to share vehicle days or vehicles between adjacent rounds. This might generate more reasonable numbers.

The second model formulated for the waste disposal group was a simplified version of the original integer programming model. Several changes were introduced into the original model. Firstly it was decided that the decision variables dealing with waste flows should be specified in terms of number of vehicle trips rather than number of tonnes. This was done partly to allow the simple haulage model to act as an introduction and partly because it was felt that the output would be more informative and more easily interpreted. Secondly it was decided that the model should not be used to select among alternative transfer station locations, but should cost out the disposal system associated with a particular transfer station location. The resulting model had the following form:

$$\text{Minimise} \quad TC = \sum_{ij} r(i,j).x(i,j) + \sum_{i} r(3).x(i,3) + z.r \qquad (12)$$

Subject to:

$$\sum_{j} x(i,j) = T(i) \qquad i = 1 \ldots n \qquad (13)$$

$$\sum_{i} c.x(i,3) \leqslant A \qquad (14)$$

$$d.z - \sum_{i} c.x(i,3) \geqslant 0 \qquad (15)$$

$$x(i,j) \geqslant 0 \text{ and integer} \qquad (16)$$

$$z \geqslant 0 \text{ and integer} \qquad (17)$$

where:

$x(i,j)$	number of trips from waste source i to destination j (j = 1,2,3 can be landfill site or transfer station)
$r(i,j)$	cost of one trip from i to j
$x(i,3)$	number of trips from source i to transfer station
$r(3)$	transfer cost per vehicle load
z	number of trips between transfer station and landfill site
r	cost of trip between transfer station and landfill site
$T(i)$	number of trips to clear waste from source i
c	collection vehicle capacity
A	transfer station capacity
d	bulk haulage vehicle capacity

Once again the logic of the model is straightforward. The decision variables are numbers of trips made along the various routes. The objective function, equation (12), simple minimises the sum of the operating costs associated with these trips. There are three types of constraints. The constraints defined by equation (13) simply ensure

that enough trips are made from waste source i to cope with all the waste generated there. Equation (14) ensures that waste flowing through the transfer station does not exceed capacity and equation (15) ensures that enough trips from the transfer station in bulk haulage vehicles are made to cope with the waste which arrives there. The model remains an integer programme. However the logic behind the use of integer variables is now different to that in the original model. In the original, integer variables were used to allow the selection of one among a set of alternative transfer station locations. Now the integer variables appear simply because half a trip does not make sense. Under normal circumstances it would have been worthwhile considering the use of a linear program. However, the waste disposal group, as the proposed final users of the model, seemed happier with a solution that involved whole numbers of trips.

Once again it should be stressed that the model was defined to cope with operating costs. It is not in itself an investment appraisal package as was the original model. $r(i,j)$ and r are trip costs based on the trip and mileage cost elements included in equation (11), and r is the cost of transfer generated by an additional trip.

The final 'model' provided for the waste disposal group is more properly described as an approach; this was the discounted cash flow approach to investment appraisal. The two models already described were designed to calculate operating costs of particular waste disposal systems in a time period. They were not designed to compare or aggregate costs occurring at different points in time. It seemed better to break this task out in a separate 'model'.

d) Sequence of Model Use

The key idea behind the separation of the analytical package into three parts was that the waste disposal group's problem could be seen as involving comparing different disposal options, where the outcome of each option was subject to considerable uncertainty, and subjective as well as objective evaluation might have its part to play. The intended pattern of model use can be made clear by drawing on the structure of the Fylde Coast problem.

Essentially, there were two possible types of solution to this problem, one which involved a transfer station and one which did not. It was intended that those solutions which did not involve a transfer station option would be analysed by use of the simple haulage model and the discounted cash flow approach. The intention was that route distances, waste quantities, and cost and capacity parameters would be fed into the simple model to produce a single period cash operating cost. The analysis would be repeated for data relating to different periods and for different possible patterns of data within a period. The best guess cash flow figures for each period would then be compared with the capital costs involved, using a risk adjusted discount rate approach.

Similarly, if a transfer station option was being considered, it was intended that route distances, and cost and capacity parameters would be included in a version of the integer programming model. Specific additional constraints might also be introduced. The model would be run to produce once again a cost for a given time period. Sensitivity

analysis would then be performed and the model rerun for data relating to other time periods. The output from the model would then be examined using the basic ideas of the simple haulage model to identify fleet size and hence period fixed costs. These fixed costs, together with operating costs produced by the model and any capital costs, would then be combined within the risk adjusted discounting framework.

It was felt that this staged approach to analysis would make 'what if' questions easier to analyse in the sense that on many occasions only one of the models might need to be used, and each model was simple to understand and operate.

8.6 Parameter Estimation[3]

a) Introduction

The simplified models which were constructed to analyse the Fylde Coast problem required a set of parameter estimates before they could be used. The parameters related to the operations of a haulage vehicle, a collection vehicle and a transfer station.

b) Haulage Vehicle Operations

An important set of parameters related to the costs of operating a haulage vehicle. There were three aspects to the haulage vehicle activity being considered, loading a vehicle at a transfer station, haul along a public highway, and tipping at a landfill site. The first two phases of the activity were relatively straightforward. However the final phase was more complex. It involved travel on the landfill site, along a road consisting of compressed domestic refuse and covering material, as well as an unloading operation. It was apparent that haulage vehicles would be particularly susceptible to damage to tyres and chassis during this final phase of the operation.

On the basis of this analysis of a haulage vehicle's operations, it was decided that two cost parameters would be necessary for the calculation of the cost of a single trip. These were a mileage related cost, and an event related cost to cover principally the unloading activity, but also the loading activity. The cost per mile parameter was based primarily on Commercial Motor data. It was decided to use a figure of

£0.17 per mile. This made allowance for fuel, oil, tyres and maintenance at the following rates:

Fuel	(pence per mile)	5.6
Oil	(pence per mile)	0.25
Tyres	(pence per mile)	3.39
Maintenance	(pence per mile)	7.65

The estimation of an event related cost parameter caused problems. In the absence of any specific information, an estimate was based on the discrepancy between Commercial Motor based costs and the total annual costs incurred by vehicles operating from the Burnley and Preston transfer stations. Unfortunately this method set only rough limits on the parameter. A low estimate of £0.5 was conceivable as was a high estimate of £1.50. On the basis of the way the Vehicle and Plant Maintenance Unit's charges allowed for tyres and repairs, a central figure of £1.00 was finally chosen.

The mileage and event related parameters served to calculate cost per trip figures. However to calculate a total cost for a haulage operation period fixed costs were also required. These were defined to include a weekly allowance for licenses, wages, and insurance. Again the Commercial Motor data were the basis for parameter estimation. However Lancashire staff provided a figure for the wage cost element. A figure of £102.07 was finally selected. This made allowance for:

License	£12.07
Wages	£69.23
Insurance	£20.77

Several non cost parameters were also established. These included an 8 hour working day for a driver, an average vehicle speed of 18 m.p.h., a turn round time of 0.5 hours, and an average vehicle capacity of 10 tonnes. These parameters were based on county records and test measurements.

In order to allow for an investment appraisal, capital cost and economic life were also recorded. It was decided that the chosen vehicles would cost £22,000.00 and last 10 years.

c) Collection Vehicle Operations

As has been indicated the districts did not hold a significant amount of collection cost data. The data which they did hold by and large consisted of little more than annual cost totals. In particular the data did not distinguish between vehicle costs incurred as a vehicle moved round the collection round and costs incurred when it moved between collection round and tip site. An attempt was made to use this data. However all that proved possible was to strip out non cash elements and calculate a simple cost per mile travelled figure. The figure obtained was £0.22 per mile.

This figure was obviously a crude average which if possible had to be improved on. Basically, collection vehicles performed three tasks. They were involved in collection, transport and unloading. In other words the threefold split which was found in the bulk haulage activity was also found in the collection vehicle operation. However there were important differences between collection and haulage operations.

Firstly, the collection vehicle's destination might be a landfill site or intermediate treatment facility. Secondly, the loading operation was infinitely more complex than that relevant to a bulk haulage vehicle. At the start of each journey the collection vehicles under consideration would typically have just completed a two hour long activity, travelling at slow speed round part of a collection round, frequently stopping, but using fuel to power the mechanism mounted on the chassis even when stopped.

Clearly some distinct cost parameter was needed to cope with this loading phase of the collection vehicle's operation. An event related parameter similar to that defined for the bulk haulage operation was an obvious candidate. Therefore an attempt was made to calculate two event related parameters. Each was intended to include the composite cost of a collection vehicle's loading and unloading operation. They differed in that one assumed that unloading took place at a tip site and the other that it took place at an intermediate treatment facility. It was felt that similar problems to those that faced a bulk haulage vehicle on a tip site would face a collection vehicle, but that these problems would be absent if unloading took place at a transfer station.

In order to estimate these parameters, use was made of both Commercial Motor data and Blackpool's data. Firstly, a cost per mile parameter was estimated on the basis of Commercial Motor data. An estimate was then made for the total annual cost of the Blackpool collection operation, using this parameter and an estimate of vehicle miles travelled. As anticipated, there was a considerable shortfall between estimate and actual. Next, an event related term to account for the

cost of the unloading operation was introduced. In the absence of any other data, the cost coefficient calculated during the analysis of haulage operations was used. Once again the estimate fell short of the actual. The unexplained residual was used in conjunction with an estimate of the number of trips to site made by the Blackpool vehicles to produce an event related coefficient designed to reflect the cost of the collection activity. The difference between the cost parameter relating to the unloading operation and that relating to the collection operation was less than might have been expected. However in the absence of further data the calculated parameters were presented to the county waste disposal group as the best available.

The cost per mile parameter was found to be £0.12 per mile. This was composed of:

Fuel	(pence per mile)	4.66
Oil	(pence per mile)	0.23
Tyres	(pence per mile)	1.34
Maintenance	(pence per mile)	5.38

The event related element for a vehicle travelling to a transfer station was estimated to be £1.20. Thus the event related element for a vehicle both collecting and unloading at a landfill site was set at £2.20.

The per period fixed cost of operation for a collection vehicle included:

Licence	£5.53
Wages	£173.08
Insurance	£9.17

The high wage figure reflected the presence of a collection crew in addition to a driver.

Non cost parameters for the collection vehicle operation included an 8 hour day, an average speed of 16 m.p.h., a 2.25 hour turn round time and an average capacity of 4 tonnes. As was the case with the haulage vehicle parameters, local authority records were the basis for these figures. It was further estimated that a typical vehicle would cost £20,000.00 and would have a 10 year life.

d) Transfer Station Operations

County waste disposal staff provided data on a transfer station operation. Capital items included:

Land and Buildings	£175,000
Shovel	£18,000
Two Compaction Units	£26,000
Dust Control Equipment	£15,000
Weighbridge	£18,000
Contingencies	£3,000

This generated a capital expenditure total of £255,000. First year running costs were estimated to include:

Shovel and Driver	£8,500
Wages	£13,800
Maintenance	£4,000
Electricity and Water	£3,000
Rates	£2,500

The total anticipated cost was £31,800. It was felt that some part of these costs should be seen as variable. However, discussions with Lancashire staff seemed to indicate that the bulk of the cost would be independent of transfer station throughput. Therefore it was decided to treat all these running costs as period costs. After discussion it was agreed that a transfer station would have an economic life of thirty years, and a capacity of 1,000 tonnes per week.

The process of discounting was not well understood by county staff. Consequently discussions about the appropriate discount rate to use in a discounted cash flow analysis were not rewarding. It was decided that a useful starting point was the 15% borrowing cost facing the county.

8.7 Analysis of the Fylde Coast Problem

a) Introduction

The availability of models, parameter estimates, data on distances to be travelled and data on waste quantities to be removed allowed analysis of the Fylde Coast problem to proceed. A FORTRAN program to deal with the simple haulage model was written and stored on the Lancashire computer installation and also on the Warwick University computer. Card decks were also prepared containing the data for the three transfer station options in forms acceptable to the mathematical programming package available on the Lancashire installation and to TEMPO, the package available at Warwick. It was decided to carry out initial analyses on the basis of the assumption that the amount of waste to be removed from the Fylde Coast region would not change with the passage of time.

b) Results of the Initial Analysis

Using the simple haulage model, the running cost of a system of disposal which did not involve a transfer station was calculated. Analysis of this solution showed that costs of shipping waste to Jameson Road and Clifton Marsh exceeded those involved in shipping waste to Midgeland Farm. Further analysis indicated that the size of the collection vehicle fleet would have to be increased. Almost as a by product, it was noted that to redirect waste from some of the rounds in the north of the Fylde Coast away from Midgeland Farm to Jameson Road would not be excessively costly. In fact in a few cases re-routing promised a cost saving.

Using the mathematical programming model, disposal systems involving each of the three possible transfer stations in turn were analysed. Each transfer station location promised a reduction in mileage and trip related costs. The greatest saving was generated by the mid-coast transfer site. The smallest saving was generated by the proposed site in the south of the region. However even in the case of the mid-coast site, the savings were relatively small. Further analysis of the three transfer station based solutions indicated that they involved similar sized collection and haulage vehicle fleets. Since they also involved similar capital expenditures and similar period costs, the mid-coast site clearly dominated the other two. It should be noted that because of the comparability of key cost items no discounting exercise was necessary to establish this dominance.

It remained to compare the solution based on no transfer stations with that based on the mid-coast site. The transfer based solution involved a smaller collection vehicle fleet than the no transfer solution. However the need to acquire bulk haulage vehicles for the transfer option offset this saving, both in capital expenditure terms and period costs. Therefore the transfer station alternative involved greater capital expenditure than the no transfer station alternative, but promised some savings in vehicle operating costs. However the period fixed costs involved in running the transfer station exceeded these savings. Therefore it could be seen that even the best of the transfer station options involved more capital expenditure and higher running costs than the no transfer situation. Once again, the dominance of the no transfer option over the transfer option was established without the need of a discounting exercise.

c) Sensitivity Analysis

Because of the poor quality of the cost parameters, the alternatives were analysed using different cost parameters. The dominance of the mid-coast transfer site over the two other locations, however, proved difficult to alter. However the high cost nature of the transfer operation as compared to the no transfer operation was less robust. The initial results, together with details of the sensitivity analysis, were presented to the county waste disposal group.

In the light of requests from the county group, the alternatives were later re-analysed under different assumptions about waste quantities to be removed.

8.8 The Lancashire Response

a) Response to the Initial Analysis

Staff in the county waste disposal group felt that the analysis confirmed their preference for a disposal system which did not involve transfer. They also felt that the results strengthened the case for pursuing an extension to the Midgeland Farm site. The fact that re-routing of waste to Jameson Road would not be too costly for some rounds was noted. It was decided to implement this re-routing as a means of extending the life of the Midgeland Farm site.

Examination of the transfer station results led to the view being formed that costs were relatively insensitive to the choice of location. Therefore as a standbye alternative it was decided to pursue the idea of a transfer station at the site closest to the Midgeland Farm tip. It was felt that in the event that a transfer station became necessary, this site would cause least convenience to the districts, in that they would not have to reorganise the pattern of collection rounds.

c) Adoption of the Models

Despite the fact that the models had been designed to allow county staff to make use of them easily, only the simple haulage model was used initially. This was unfortunate, since it tended to focus attention on variable costs to the exclusion of fixed costs. This led to some early misinterpretation of the outputs of the computer analyses. In retrospect, this could have been avoided if more guidance had been

provided by the author. However the use of the simple haulage model did point the way to steps which could reduce the pressure on the Midgeland Farm site.

It was hoped that after using the haulage model, county staff would move on to analysing the transfer station options more carefully using the mathematical programming approach. However any moves in this direction were frustrated. The haulage model could be run on a desk calculator and the mathematical programming model required a computer with which staff were unfamiliar. The lack of familiarity with the computer proved to be a barrier which was difficult to overcome. The replacement of the Lancashire computer by a new machine did nothing to help the situation. The Technical Services Group immediately faced a major increase in workload and the needs of the waste disposal group tended to be given low priority since their programs were used so infrequently. A final blow was the departure to new jobs of the members of the computer staff who had initially been involved with the Fylde Coast problem.

In the face of Lancashire's problems, the models were maintained on the Warwick computer. However this was unsatisfactory, and although further analysis was carried out for Lancashire, the models tended to fall into disuse.

8.9 Conclusion

a) The Value of the Lancashire Study

It was made clear to both the Lancashire waste disposal group and to the D.O.E. that although the problem facing Lancashire was interesting in itself, the author had almost an ulterior motive for wishing to become involved. It was made clear that the opportunity would be taken to observe, for example, the state of county/district relations and the extent of data collection activities to provide inputs to this thesis. The Lancashire field study is then a block of evidence which can be related to the hypothesis sets established in Chapter 5. However the task of relating this particular evidence to the hypothesis will be postponed for the moment. All the evidence which has been collected will be related to the hypothesis sets in Chapter 10.

Notes

1. The data provided in the appendix, together with parameter estimates included in the text, are sufficient to allow the simple models presented later to be run.

2. The simple haulage model has since appeared in Wilson (1980).

3. Despite the problems involved in parameter estimation, some of these figures have since been reported in the literature as "best available estimates" (ibid).

9.0 THE WARWICKSHIRE FIELD STUDY

9.1 Introduction

a) Lancashire and After

By late 1977 the Lancashire work was well developed. Problems of data availability had been met, and remedied as far as was possible, and county staff had been involved in early computer runs. However no further problems like the Fylde Coast problem were being dealt with by the Lancashire waste disposal group. Therefore the wider applicability of the problem-solving approach adopted to deal with the Fylde Coast problem remained unproven. Consequently, when Warwickshire's waste disposal group approached the author with a request for assistance in analysing a disposal problem, the opportunity for further work was seized on.

At first sight, the Warwickshire problem seemed similar to that faced in Lancashire. The landfill sites serving a particular area of the county were almost full and an alternative had to be selected from among a set of possibilities. The basic alternatives were new sites, but a transfer activity was also being considered. An additional incentive to carry out the work was that county officers indicated that problems of data availability were unlikely to be as serious as those faced in Lancashire.

9.2 Problem Structure

a) Existing Operations

In 1977, the two districts of North Warwickshire and Nuneaton and Bedworth sent waste to the "Blue Lagoon" tip site which was located inside Nuneaton and Bedworth district's boundaries. North Warwickshire also made use of another site located near Coleshill. Both the Blue Lagoon and Coleshill sites were expected to be full by the end of 1978. Coleshill was expected to close in June 1978 and Blue Lagoon in September 1978. The Warwickshire waste disposal group had available several short term options which could cope with the problem, use of a privately owned site near Coleshill, waste incineration at the Coventry incinerator, and use of a small landfill site, the Griff site, close to Blue Lagoon, being the principal ones. However it was felt that action should be taken to identify a disposal facility which North Warwickshire and Nuneaton and Bedworth could use in the long term.

b) Possible Alternatives

The Warwickshire waste disposal group had identified several disposal systems which could replace the Coleshill/Blue Lagoon combination. One possibility was that a long term agreement could be sought with the West Midlands County Council, the owners of the Coventry Incinerator, to allow waste from Nuneaton and Bedworth and North Warwickshire to be incinerated at Coventry. It was felt that although a fee would be charged by West Midlands, excess capacity at the Coventry Incinerator,

coupled with a need to burn waste to satisfy contracts to supply heat to factories near to the incinerator, argued that the fee would be negotiable. A second possibility was seen to be long term use of a privately owned site near Coleshill. Again this would be on a fee-paying basis.

One set of alternatives being considered involved the opening up of a major new landfill site. Several possible sites were available in the Nuneaton and Bedworth/North Warwickshire area due to the existence of a long standing quarrying activity. County officers had tentatively identified four potential sites which appeared to offer adequate capacity to cope with the needs of Nuneaton and Bedworth and North Warwickshire. In what follows, these sites will be identified as sites A, B, C and D. Their locations will not be specified to avoid prejudicing any future county negotiations with their owners.

County officers had also given consideration to the possibility of opening a new site and building a transfer station to enable waste from the more distant parts of North Warwickshire and Nuneaton and Bedworth to be taken to the landfill site more economically. A single potential transfer station site had been identified near Coleshill. However it was felt that others might be identified if the transfer option began to look particularly attractive.

c) Basic Objectives

Discussions with county officers indicated that the relative costs of the alternative disposal schemes would be crucial in deciding which to pursue. Other criteria, such as environmental pollution for example,

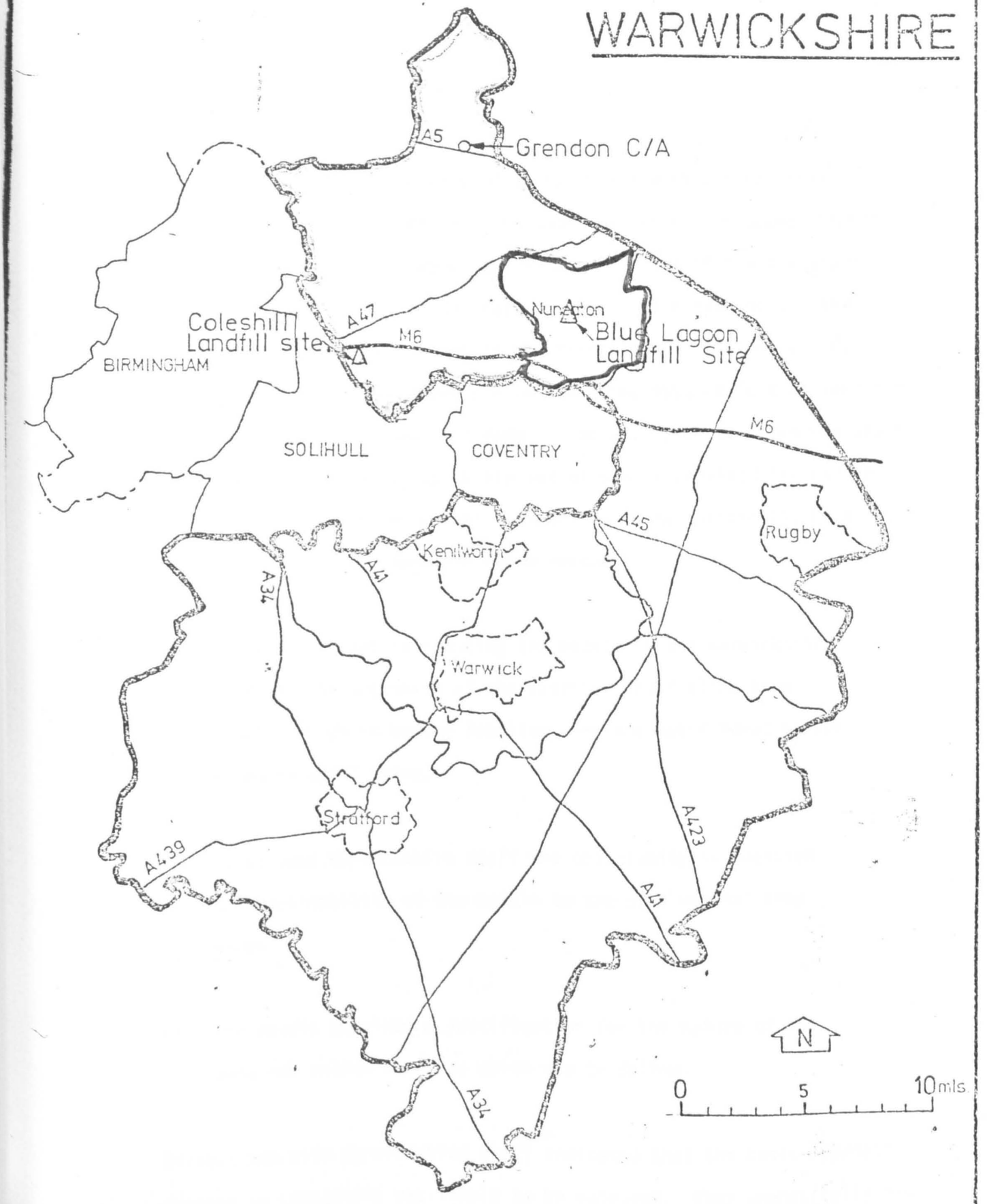
were seen as either already having been taken care of in site selection or as requiring sensible operation of those facilities involved in the disposal system finally selected.

d) Geographical Factors

The Nuneaton and Bedworth/North Warwickshire problem was seen as separate from the rest of the Warwickshire waste disposal network because of the shape of the county itself. As can be seen in Figure 9.2.1, Warwickshire is effectively split into two parts by a combination of the West Midlands County and the M6 motorway. There is a Northern area consisting of Nuneaton and Bedworth and North Warwickshire, and a Southern area consisting of Warwick and Stratford. For many purposes Rugby provides a link, but in terms of waste disposal, Rugby tended to be grouped with the Southern part of the county.

This geographical layout went some way towards indicating that at least one of the disposal options being considered, long haul to the Coventry Incinerator, was likely to be an unsatisfactory replacement for the Blue Lagoon site. Because the incinerator was situated in the South East of Coventry, collection vehicles from North Warwickshire and Nuneaton and Bedworth would either have to travel a long distance around the West Midlands or travel relatively slowly through a heavily built up area.

Figure: 9.2.1


WARWICKSHIRE
A5
Grendon C/A
Coleshill
Landfill site
A47
M6
Nuneaton
Blue Lagoon
Landfill Site
BIRMINGHAM
SOLIHULL
COVENTRY
M6
A45
Rugby
Kenilworth
A41
A34
Warwick
Stratford
A439
A423
A41
A34
N
0
5
10mls

9.3 Data Collection

a) Structuring the Data Collection Exercise

Staff in the Warwickshire waste disposal group were already familiar with the broad outlines of the work done for Lancashire County Council. It was awareness of this work, and an appreciation of the similiarity of their problem to the Fylde Coast problem, which had led to them making contact with the author in the first place. To some extent then, it would have been feasible to start the data collection exercise at once. However that was not done. Time was taken to introduce staff in the waste disposal group to the set of models provided for use in Lancashire and to the more complex model which had originally been formulated. This was done for three reasons:

(1) It was felt that introducing the models to the Warwickshire staff at the beginning of the exercise would allow them time in which to become familiar with the basic ideas before becoming model users.

(2) It allowed Warwickshire staff the opportunity to question the applicability of the models to the problem that they faced.

(3) The models provided a justification for the nature of the data collection exercise which was to follow.

Discussions with Warwickshire staff indicated that the basic approach adopted in Lancashire was likely to be relevant. They emphatically did

not want a model which purported to provide a solution to the Blue Lagoon problem while hiding from them the ideas underpinning the proposal. Hence the idea of a package of simple models which would allow them to evaluate alternatives found favour. Warwickshire staff also indicated that the basic structure of the models did not appear unreasonable, although they clearly felt that data would be available to allow a more realistic specification of cost functions.

As in the Lancashire case, the role of a model in specifying the types of data to be collected was seen as particularly valuable. It was felt that the fact that specific questions could be posed right from the start would ease the data collection task.

b) Waste Quantity Data

County officers were able to produce figures for the total amounts of waste dumped at the Blue Lagoon and Colehill landfill sites. These figures were based on the number of vehicles arriving at the sites and an estimate of the load tipped by an average vehicle,3-5 tonnes. It was estimated on this basis that Blue Lagoon was receiving 59,400 tonnes per year and Coleshill 16,000 tonnes per year. It was stated that the only waste going into Coleshill was from North Warwickshire, but that Blue Lagoon was receiving trade waste as well as waste from Nuneaton and Bedworth and North Warwickshire. County officers estimated the amount of waste from North Warwickshire going into Blue Lagoon at 9,400 tonnes per year.

In order to refine these estimates of aggregate waste flows both Nuneaton and Bedworth and North Warwickshire district councils were

contacted. Nuneaton and Bedworth was able to provide data on sample weighings of waste from each collection round. The data were recent, having been collected in the previous year. On the basis of these sample weighings it seemed that 27,000 tonnes of waste per annum were generated in Nuneaton and Bedworth. North Warwickshire, however, was unable to provide any data on weight of waste collected. An "informed estimate" was available from staff which suggested that a total of 15,000 tonnes per year was collected and that 8,500 went to the Blue Lagoon site and the remaining 6,500 tonnes to Coleshill.

These data raised two problems. Firstly, it was clear that county and district estimates of waste generated in North Warwickshire differed dramatically. The county's estimate was 25,400 tonnes per year while the district's estimate was only 16,000 tonnes. Secondly, it was clear that identifying a set of waste sources and waste quantities for North Warwickshire was going to be difficult.

It was decided that the only way to overcome these problems was to provide a method of estimating waste quantities arising in North Warwickshire which would allow disaggregation. A vehicle count seemed to be one possibility and a bin count another. North Warwickshire was therefore asked for a copy of its bin register, a list of all addresses from which a dustbin had to be regularly collected. This was readily available. It took the form of a list of streets, organised by collection round, and a set of figures for the number of bins to be collected from each street. In discussions with Nuneaton and Bedworth staff, figures had been quoted for the average weight of refuse in a dustbin in a non-coal burning area, 25 lbs, and in a coal burning area,

28 lbs. The difference was of course due to the presence of ash. Discussions with North Warwickshire staff indicated that there was no reason to suppose that North Warwickshire bins should be different from Nuneaton bins and so it was decided to use these figures to generate an estimate of waste produced in North Warwickshire.

On the basis of the bin register, a figure for tht total weight of waste produced per annum in North Warwickshire was estimated. This came to a little over 15,000 tonnes per annum. This was consistent with the estimate current in the North Warwickshire district. To validate the method, a figure for the number of bins collected in each Nuneaton round was requested from Nuneaton officers. This was immediately forthcoming. Officers stated that each round in Nuneaton consisted of 3,750 bins and each round in Bedworth of 3,250. Using these figures, the bin capacity figures, and a knowledge of the number of collection rounds, an estimate of weight of waste arising per annum was made. This estimate came to just under 29,000 tonnes. Given that an average of the two bin capacity figures was used in this calculation as a shortcut, the discrepancy between the sample weighing based figure and the bin count based figure was not thought to be high. Therefore, it was felt that some confidence could be placed in the estimate of weight of waste produced by North Warwickshire and also the bin count based method of estimation.

County officers were told that their estimate of the weight of waste being produced in the North Warwickshire area seemed to be heavily in error. They were asked to check their estimate of the amount of waste flowing into the Coleshill tip in particular. Spot checks revealed

that the tip site was in fact being used by vehicles from a non-Warwickshire district. The vehicles from this district had at one time been allowed the use of the Coleshill site as a temporary measure. Warwickshire staff had terminated the arrangement, but information had not filtered through to the district concerned. Vehicle counts at the Coleshill tip had simply counted vehicles from two districts and assumed all vehicles belonged to North Warwickshire.

It is often said in the management science literature that a host organisation benefits as much from the side effects of a problem solving exercise as from having its problem solved. The removal of the confusion about the amount of waste generated in North Warwickshire was a case in point. Better communications between district and county came about and Warwickshire was able to save tipping capacity by curtailing unauthorised use of the Coleshill site.

c) The Assignment of Waste to Sources

The bin count method of estimating weight of waste arising allowed the North Warwickshire waste total to be split up into waste amounts arising at particular locations. This was necessary to allow a Lancashire type L.P. model to be used. Initially it was intended to assign waste to collection rounds and to identify round centres as waste sources.

However, North Warwickshire proved to operate only nine rounds and the more rural of these covered a wide geographical area. Therefore it was decided to use the bin register to assign waste to a larger number of more compact areas.

At the time the study was being carried out, North Warwickshire was attempting to reorganise its collection operation. Therefore, district staff had already given some thought to the question of what a new system of collection rounds might look like. With the help of district staff it proved possible to identify eighteen building blocks which might serve as collection rounds on their own, or which might be added together to make up a collection round. The criteria for defining these building blocks were that each block should contain enough waste to provide a collection vehicle with at least one full load per week, and that the block should not be too spread out geographically. This second criterion is obviously subjective and therefore the eighteen building blocks were not uniquely defined. However, it was decided to use them in the study, and to point out to county staff that as information about new round structures became available for North Warwickshire, it should be utilised.

For the eighteen building blocks, waste quantities were calculated using the bin register, and geographical block centres were established from which travel distances to site locations could be measured. County staff were provided with a set of weight of waste figures and a list of map references for these block centres. Likely collection vehicle routes between blocks and possible site locations were then established in consultation with district officers, and some problematic routes were driven along to confirm their acceptability. Finally route distances were established using ordinance survey maps and a measuring wheel.

The task of identifying point waste sources for Nuneaton and Bedworth was much simpler. Compact urban rounds were already defined, seven in Nuneaton and five in Bedworth. District records in fact identified an eighth Nuneaton round, but this proved to relate to the activities of a bulk collection vehicle which travelled throughout the town. Sample weight of waste figures were available for all the rounds as was stated earlier.

Geographical round centres were identified for the seven Nuneaton rounds and the five Bedworth rounds. To establish the distances between these round centres and the various possible collection vehicle destinations, ordinance survey maps and a measuring wheel were used. In order to estimate the weight of waste arising at each round centre, the waste collected in Nuneaton by the bulk collection vehicle was allocated to the other Nuneaton rounds according to the proportion of non-bulky waste arising in each round. Round centre map references and weight of waste figures were provided to county staff.

d) Collection Cost Data

County officers indicated that data on collection vehicle costs should be relatively easy to obtain. District officers in Nuneaton and Bedworth and North Warwickshire who should be contacted were identified by county staff, and these were approached by the author. In each case, the staff were in the Treasurer's Department, and not in the department responsible for running the collection vehicles.

North Warwickshire was contacted first. While the relevant staff were helpful, data were largely unavailable. To some extent this was

because part of the vehicle fleet was maintained by another non-Warwickshire district. This was a legacy of the pre-local government reorganisation pattern of local authorities. Cost data on these vehicles was non-existent; only a service charge figure was available. For the rest of the vehicle fleet, cost data were available on a vehicle by vehicle basis. Unfortunately the cost data were available only in aggregate form, and corresponding data on vehicle activity levels were not kept.

Despite the willingness of district staff to cooperate, it was clear that as far as the availability of collection cost data was concerned North Warwickshire was on a par with the Lancashire districts. Therefore, attention was turned to the situation in Nuneaton and Bedworth. District staff there had recently introduced a computerised accounting system. They were therefore able to make available monthly cost data on a vehicle by vehicle basis. Associated with the cost data were data on vehicle activity levels. A preliminary examination indicated that although there were problems in the data capture processes which underpinned the computerised accounting system, and in the failure of the system itself to present data in such a way that cost elements added up to cost totals, the data were potentially extremely useful. Unfortunately shortly after this preliminary examination, district officers indicated that they were unwilling to make the data available to the county. The reason given was that they might at some stage wish to hire vehicles out to the county, or negotiate about compensation for excessive travel by collection vehicles.

County officers contacted Nuneaton and Bedworth to try and change this decision, as did the author, but with little success. Eventually it

was suggested that the author would be allowed access to the data if county staff could in some way be prevented from sharing that access. This would have meant, either giving county staff a solution to the disposal system selection problem they were facing, and asking them to take it on trust, or giving them a black box with which to solve the problem. Neither option was acceptable to county staff. They wished to be able to participate in the analysis of the various disposal options.

It became clear that although it was desirable to use the data held by Nuneaton and Bedworth, there were major problems standing in the way. Therefore, it was decided to ignore the data to a large extent. Discussions with county staff led to a decision being made to make use of Commercial Motor data and inflation adjusted versions of the cost parameters calculated during the Lancashire study. (The author had already confirmed that Nuneaton and Bedworth data broadly supported this approach.) County officers seemed to feel that using this data set would allow them to participate in the analysis, and would establish estimates of collection costs born by Nuneaton and Bedworth which district staff could only challenge by making public their own data. Table 9.3.1 contains a typical set of collection parameters.

e) Haulage Cost Data

Because there was a possibility that the disposal system selected to replace Blue Lagoon might involve a transfer station, it was necessary to find cost data for bulk haulage vehicles as well as collection vehicles. County staff specified the bulk haulage vehicle they would use as an

TABLE: 9.3.1

Basic Cost Parameters to be Used in Warwickshire Study

Haulage vehicles

D	driver's working day	(hrs)	8.00
V	average vehicle speed	(m.p.h)	18.00
C	average capacity	(tons)	10.00
t	total turn round time	(hrs)	0.5
C(2)	running cost/mile	(£)	0.23
C(3)	event related cost	(£)	1.33

Collection vehicles

D	8
V	15
C	4
t (tip)	2.25
t (transf)	2.25
C(2)	0.16
C(3) (collect and tip)	3.00
C(3) (collection and transfer)	2.00
(Days/wk)	5

"ATK Multilift". This vehicle had a theoretical carrying capacity of 12 tonnes, which in practice, because of compaction problems, became a capacity of 10 tonnes. Commercial Motor data on similar vehicles were available, as were details of charges made by the contracter who provided the vehicles for the county's Rigby Road transfer operation. The Rigby Road operation was costed using Commercial Motor data and the simple haulage model developed for Lancashire. County officers examined the resulting estimates in the light of the fees paid to the contracter. In the light of this comparison, they requested that the Blue Lagoon situation should be analysed on the basis of Commercial Motor data. Table 9.3.1 contains a typical set of haulage parameters.

f) Transfer Station Cost and Capacity

County officers had in mind a very simple transfer station structure, essentially no more than a covered ramp. On the basis of previous experience, officers indicated that a station capable of handling up to 500 tonnes of waste per week would involve an investment cost of £150,000, while a station capable of handling between 500 and 1500 tonnes would cost twice that. Running costs were seen as relatively fixed and related to a basic requirement to employ two men on site. An annual cost of £17,000 was established as reasonable (in then current cost terms) for the transfer operation.

It is worth pointing out here, that the view of transfer station costs put forward by Warwickshire staff supported the treatment of transfer station costs adopted during the Lancashire field study. In that case, it was decided to treat the costs of the transfer station operation as

period fixed costs rather than as costs which varied with the level of transfer station throughput.

g) Costs Involved in Developing Tip Sites

County officers had carried out a preliminary analysis of sites A, B, C, D. They felt that sites A, B, D were similar, in that each would require an initial investment expenditure of £120,000 to cover the installation of a weighbridge and the provision of access roads. Site C was seen as requiring a larger initial investment; the sum of £200,000 was seen as the minimum necessary. These initial investment figures did not include necessary initial expenditure to cover the purchase of void. Each site offered approximately one million cubic metres of void, and county officers felt they might have to pay 10 pence per cubic metre. This figure was of course no more than a provisional estimate. County officers stated that there was no reason to believe that the price of void would differ between sites.

As far as running costs were concerned, officers saw them as varying with throughput according to a simple step function. It was felt that a site taking in up to 500 tonnes per week would cost £23,000 per annum to run, that one taking in between 500 and 1200 tonnes per week would cost £40,000 per annum, and that one taking in over 1200 tonnes would cost £63,000 per annum. These total costs were seen as covering labour, rentals, rates and other charges. The basic idea was that more men would be required to run the site as waste flow increased. The £40,000 per annum charge was seen as corresponding to the cost of operating the Blue Lagoon site.

Again the implication of the county view was that running costs should be treated as a period cost rather than as a cost per tonne figure, with £40,000 per annum being the most likely figure for a site equivalent to that at Blue Lagoon.

9.4 Model Selection and Use

a) Links with Lancashire

Despite hopes to the contrary the Warwickshire districts contacted did not provide sufficient cost data to make possible any improvements on the form of the cost functions used in the mathematical models. The additional cost data which did become available related to landfill and transfer operations, and these data tended to support the treatment of costs adopted for Lancashire. Therefore, using the Lancashire models as they stood was an option available to Warwickshire county staff.

However before adopting this course of action, the author and county staff considered three major issues. Firstly the rationale for using a set of simple evaluation models rather than a single more complex evaluation and selection model was examined. Officers re-emphasised their desire to participate in the analysis, and argued that the use of simple models would allow them to do that more effectively. They also confirmed that they felt that non-cost issues should be dealt with outside the formal models. The need for sensitivity analysis and the potential need to use the models to support a negotiating process were also seen to be as much a part of the Warwickshire situation as they had been in the Lancashire case, if not more so.

Secondly, the particular problem raised by the fact that North Warwickshire was restructuring its collection system was discussed. It was agreed that the inability to locate waste sources in an unambiguous

fashion did not fit in well with the requirements of the Lancashire models. However it was felt that the problem could be overcome by seeing how sensitive the models were to an alternative set of waste source locations for North Warwickshire, and by taking new North Warwickshire data into account when it became available.

Thirdly, the possibility of gaining access to the data set held by Nuneaton and Bedworth was discussed. It was agreed that in the event of this becoming available, its implications for parameter values and equation forms should be considered. However officers did not seem unduly purturbed by the absence of this data. They indicated that using Commercial Motor data had at least two advantages, namely that it was a private sector base case against which public sector costs might usefully be compared, and that it was provided by an organisation unlikely ever to wish to use its data as the basis for a compensation claim against the county.

On the basis of the above considerations, county staff decided that the set of models used in the Lancashire study; a simple haulage model, an integer programming model, and the discounted cash flow approach, should be used to help analyse the set of alternative disposal systems which might replace the Blue Lagoon site.

b) Alternatives to be Analysed

Examination of the possible replacements for Blue Lagoon showed that they fell into two distinct groups, those involving a transfer station and those not involving a transfer station. The analysis of

those involving a transfer station required the use of the integer programming model before any discounted cash flow comparison could be undertaken. The analysis of those not involving a transfer station required only the application of the simple haulage model prior to a discounted cash flow comparison.

Within each of the two groups there were six alternative systems for consideration based on landfill sites, A, B, C, D, the Coventry incinerator and a privately owned landfill site. It was agreed that consideration of those systems based on the Coventry incinerator and the privately owned site should be left until last.

c) Computational Problems

County staff indicated that they had no experience of using computers to analyse waste management problems. Consultations with staff in the county's computer unit were therefore set up. It transpired from these that there were no problems in locating a FORTRAN version of the simple haulage model on the county computer, but that there was no integer programming facility present in the mathematical programming package which was available. Because of the nearness of the University, county waste disposal staff were offered the alternative of using the University's Burroughs machine in conjunction with the TEMPO mathematical programming package. This package included an integer programming facility. County staff decided to use the University facility and to request the county computer unit to acquire an integer programming package.

To assist county staff to come to terms with the models, the author developed a programme of the simple haulage model which would be run on a Sinclair Programmable Calculator. This was given to county staff to allow them to begin to analyse the landfill only systems which were being considered.

d) The Process of Analysis

It was decided to begin by analysing the landfill only based systems involving sites, A, B and D. The process of analysis was straightforward. Firstly, for a given site, a list of distances between the thirty identified waste sources and the site, and a list of quantities of waste to be removed, were constructed. Secondly, the simple haulage model was applied to this data to create a list of numbers of trips required to clear the waste sources, and a second list of individual trip costs for each waste source. Multiplication and summation gave a total running cost for the system. Thirdly, the simple haulage model was used to establish the number of vehicle days required to clear each waste source. The geographical pattern of the required vehicle days was then examined to see where vehicle days could be shared between sources. On the basis of this analysis, a total number of vehicle days required was established. This figure was easily translated into a required collection fleet size for the system.

For each landfill site, the above process was first of all carried out by the author and county officers using a programmable calculator. The author and county staff then carried out sensitivity analysis using the FORTRAN version of the haulage model stored on the Warwick computer.

The same approach, using first a programmable calculator and then the Burroughs mainframe was followed in analysing the system based on landfill site C. . County staff agreed to carry out similar analyses for the systems based on the Coventry incinerator and the privately owned site near Coleshill for themselves.

The analysis of the systems which did not involve the transfer station provided the bulk of the data required to analyse the 'with transfer station' systems. The only additional parameters which had to be calculated prior to running the integer programming model were those which related to the movement of waste between waste sources and the transfer station and between transfer station and tip site. Therefore the necessary list of distances was created and the simple haulage model used to generate cost per trip coefficients. Each run of the integer programming model involved a common set of data dealing with the routes between transfer station and waste sources. However the data relating to routes which ended at the landfill site varied between runs. County staff were shown how to create card decks and how to interpret the resulting computer output. They were allowed limited access to the author's computer usercode to allow them to carry out further analysis on their own.

Table 9.4.1 contains a set of results typical of those achieved when analysing a non-transfer based system. The column headed "Vehicle Days/Week" is based on the number of trips between each waste source and the potential tip under consideration which could be fitted into a working day. The column headed " Fleet Size" contains the number of vehicle days required after taking into consideration the possibility

TABLE 9.4.1

"Analysis of B"

	REQUIRED NO OF TRIPS	COST/TRIP £	RUNNING COST/WK	VEHICLE DAYS/WK	FLEET SIZE
NW1	5	3.64	18.20	2	3
NW2	3	4.41	13.23	2	
NW3	2	4.14	8.30	1	1
NW4	12	4.54	54.48	6	6
NW5	5	5.69	28.45	3	3
NW6	10	5.94	59.40	5	5
NW7	2	6.20	12.40	1	1
NW8	4	7.74	30.96	4	
NW9	2	6.33	12.66	1	1
NW10	2	7.10	14.20	1	1
NW11	3	6.33	18.99	2	2
NW12	16	6.84	109.44	8	8
NW13	3	4.98	14.94	2	2
NW14	1	7.99	7.99	1	5
NW15	4	5.88	23.52	2	2
NW16	1	6.07	6.07	1	1
NW17	2	7.80	15.60	2	
NW18	4	5.56	22.24	2	2
N1	11	3.77	41.47	4	4
N2	11	3.51	38.61	4	4
N3	13	3.19	41.47	5	5
N4	15	4.02	60.30	5	5
N5	10	3.45	34.50	4	4
N6	11	3.83	42.13	4	4
N7	14	3.38	47.32	5	5
B1	10	4.86	48.60	5	5
B2	8	4.24	34.72	4	4
B3	9	4.15	37.35	5	5
B4	10	4.66	46.60	5	5
B5	12	4.34	52.08	6	6
			996.12		99/5
					20 VEHICLES

of sharing vehicle days between waste sources. Dividing the sum of the elements in this column by 5 gives the required fleet size.

Table 9.4.2 contains a set of results typical of those achieved from an analysis of a system involving transfer. This table retains the output pattern produced by TEMPO. The portion of the table headed "Rows Section" has a row headed "COST" which is the objective function, and a row for each constraint in the programme. For example, row 3, with the name N2, relates to the constraint that enough trips to clear waste from source N2 must be made. In the case of "COST", the column headed "ACTIVITY" contains the value of the objective function. In the case of rows 2 to 32 the entry measures collection vehicle trips made. The column headed "SLACK ACTIVITY" is largely irrelevant given that the constraints are largely equalities. However the element in row 32 is interesting in that it shows the extent to which transfer station capacity is unused. The entries in the columns headed "LOWER LIMIT" and "UPPER LIMIT" simply reflect the nature of the constraints and provide no new information. Because of the prevalence of equality constraints much the same can be said about the entries in the column headed "DUAL ACTIVITY". Only the elements corresponding to rows 32 and 33 offer additional information. The absence of an entry for row 32 reflects the fact that a change in the capacity of the transfer station would not affect the objective function value, and the negative entry in row 33 reflects the fact that forcing additional waste to flow through the transfer station would increase the cost of the disposal operation.

The portion of the output headed "COLUMNS SECTION" identifies the

routes along which waste is transported and the number of trips made along these routes. For example row 93 deals with the number of trips made from waste source NW3 to the landfill site. (If the entry under "NAME" ends in a 2, then the destination is the landfill site, while if the final digit is a 1, the destination is the transfer station.) The entry in the column headed "ACTIVITY" gives the number of trips involved. Of the remaining columns those headed "INPUT COST", "LOWER LIMIT" and "UPPER LIMIT" simply reflect data input. Only the column headed "REDUCED COST" provides new information. The elements in this column show the amount by which overall disposal cost would increase, if the solution was forced to include a trip along the route to which the row refers. Their interpretation is however confused because of the use of integer variables.

Using data on the number of trips which can be made along a route per day, (which can be generated using the simple haulage model), the size of the fleet of collection and haulage vehicles implied by the computer output is easily discovered. Thus similar information can be made available for systems involving transfer as for systems which do not.

e) System Comparison

Once the trip related costs of the various systems had been calculated, system comparison could proceed. Analysis showed that the systems based on sites A, B, D, and which did not involve transfer, involved similar set up costs, similar vehicle fleet sizes and were unlikely to involve districts in purchasing additional vehicles. They could therefore be compared without use of discounted cash flow analysis.

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ROWS SECTION

NUMBER	NAME	STATUS	ACTIVITY	SLACK ACTIVITY	LOWER LIMIT	UPPER LIMIT	DUAL ACTIVITY
1	COST	BS	1093.42000	-1093.42000	NONE	NONE	1.00000
2	[illegible]	EQ	11.00000	.	11.00000	11.00000	-4.28000
3	N2	EQ	11.00000	.	11.00000	11.00000	-4.15000
4	N3	EQ	13.00000	.	13.00000	13.00000	-3.51000
5	N4	EQ	15.00000	.	15.00000	15.00000	-3.93000
6	N5	EQ	10.00000	.	10.00000	10.00000	-3.99000
7	N6	EQ	11.00000	.	11.00000	11.00000	-5.18000
8	N7	EQ	14.00000	.	14.00000	14.00000	-4.28000
9	N1	EQ	10.00000	.	10.00000	10.00000	-5.18000
10	N2	EQ	8.00000	.	8.00000	8.00000	-4.92000
11	N3	EQ	9.00000	.	9.00000	9.00000	-4.92000
12	N4	EQ	10.00000	.	10.00000	10.00000	-5.30000
13	N5	EQ	12.00000	.	12.00000	12.00000	-4.92000
14	NW1	EQ	5.00000	.	5.00000	5.00000	-3.32000
15	NW2	EQ	3.00000	.	3.00000	3.00000	-4.15000
16	NW3	EQ	2.00000	.	2.00000	2.00000	-3.64000
17	NW4	EQ	12.00000	.	12.00000	12.00000	-3.96000
18	NW5	EQ	5.00000	.	5.00000	5.00000	-5.18000
19	NW6	EQ	10.00000	.	10.00000	10.00000	-5.43000
20	NW7	EQ	2.00000	.	2.00000	2.00000	-5.55000
21	NW8	EQ	4.00000	.	4.00000	4.00000	-5.63000
22	NW9	EQ	2.00000	.	2.00000	2.00000	-5.82000
23	NW10	EQ	2.00000	.	2.00000	2.00000	-6.65000
24	NW11	EQ	3.00000	.	3.00000	3.00000	-5.88000
25	NW12	EQ	16.00000	.	16.00000	16.00000	-4.41000
26	NW13	EQ	3.00000	.	3.00000	3.00000	-4.41000
27	NW14	EQ	1.00000	.	1.00000	1.00000	-5.95000
28	NW15	EQ	4.00000	.	4.00000	4.00000	-5.69000
29	NW16	EQ	1.00000	.	1.00000	1.00000	-5.33000
30	NW17	EQ	2.00000	.	2.00000	2.00000	-4.93000
31	NW18	EQ	4.00000	.	4.00000	4.00000	-5.30000
32	OF1	BS	25.00000	100.00000	NONE	125.00000	.
33	CLEAR	LL	.	.	.	NONE	-0.50750

TABLE 9.4.2.

WARWICKSHIRE OUTPUT

COLUMNS SECTION

NUMBER	NAME	STATUS	ACTIVITY	INPUT COST	LOWER LIMIT	UPPER LIMIT	REDUCED COST
49	XP11	IV	.	6.74000	.	11.00000	4.49000
50	XP21	IV	.	6.22000	.	11.00000	4.10000
51	XA31	IV	.	5.71000	.	13.00000	4.23000
52	XP41	IV	.	5.46000	.	15.00000	3.59000
53	XP51	IV	.	6.35000	.	10.00000	4.48000
54	XP61	IV	.	6.74000	.	11.00000	3.59000
55	XP71	IV	.	6.19000	.	14.00000	3.85000
56	XP11	IV	.	6.10000	.	10.00000	2.95000
57	XP21	IV	.	7.12000	.	8.00000	4.23000
58	XP31	IV	.	6.67000	.	9.00000	3.78000
59	XP41	IV	.	7.18000	.	10.00000	3.91000
60	XP51	IV	.	5.25000	.	12.00000	2.35000
61	XNW11	IV	.	5.33000	.	5.00000	4.04000
62	XNW21	IV	.	5.14000	.	3.00000	3.02000
63	XNW31	IV	.	5.71000	.	2.00000	4.10000
64	XNW41	IV	.	5.71000	.	12.00000	3.78000
65	XA151	IV	.	5.14000	.	5.00000	1.99000
66	XP161	IV	.	5.58000	.	10.00000	2.18000
67	XN171	IV	.	4.11000	.	2.00000	0.58000
68	XP181	IV	4.00000	3.60000	.	4.00000	.
69	XN191	IV	.	4.56000	.	2.00000	0.77000
70	XNW101	IV	.	6.99000	.	2.00000	2.37000
71	XN111	IV	.	7.06000	.	3.00000	3.21000
72	XP2121	IV	16.00000	2.38000	.	16.00000	.
73	XP3131	IV	.	4.30000	.	3.00000	1.92000
74	XP4141	IV	1.00000	3.92000	.	1.00000	.
75	XN5151	IV	2.00000	3.66000	.	4.00000	.
76	XP6161	IV	.	5.07000	.	1.00000	1.80000
77	XP7171	IV	2.00000	2.90000	.	2.00000	.
78	XP8181	IV	.	3.54000	.	4.00000	0.27000
79	XP12	IV	11.00000	4.23000	.	11.00000	.
80	XP22	IV	11.00000	4.15000	.	11.00000	.
81	XP32	IV	13.00000	3.51000	.	13.00000	.
82	XP42	IV	15.00000	3.90000	.	15.00000	.
83	XP52	IV	10.00000	3.90000	.	10.00000	.
84	XP62	IV	11.00000	5.18000	.	11.00000	.
85	XP72	IV	14.00000	4.29000	.	14.00000	.
86	XP82	IV	10.00000	5.18000	.	10.00000	.
87	XP92	IV	8.00000	4.92000	.	8.00000	.
88	XP102	IV	9.00000	4.92000	.	9.00000	.
89	XP112	IV	10.00000	5.39000	.	10.00000	.
90	XP122	IV	12.00000	4.92000	.	12.00000	.
91	XP1312	IV	5.00000	3.32000	.	5.00000	.
92	XP1422	IV	3.00000	4.15000	.	3.00000	.
93	XP1532	IV	2.00000	3.64000	.	2.00000	.

TABLE 9.4.2 (cont.)

COLUMNS SECTION

NUMBER	NAME	STATUS	ACTIVITY	INPUT COST	LOWER LIMIT	UPPER LIMIT	REDUCED COST
94	XE*42	IV	12.00000	3.96000	.	12.00000	.
95	XE*52	IV	5.00000	5.18000	.	5.00000	.
96	XE*62	IV	10.00000	5.43000	.	10.00000	.
97	XE*72	IV	2.00000	5.56000	.	2.00000	.
98	XE*82	IV	.	7.22000	.	4.00000	1.59000
99	XE*92	IV	2.00000	5.82000	.	2.00000	.
100	XE*102	IV	2.00000	6.65000	.	2.00000	.
101	XE*112	IV	3.00000	5.84000	.	3.00000	.
102	XE*122	IV	.	6.46000	.	16.00000	2.05000
103	XE*132	IV	3.00000	4.41000	.	3.00000	.
104	XE*142	IV	.	7.67000	.	1.00000	1.72000
105	XE*152	IV	2.00000	5.69000	.	4.00000	.
106	XE*162	IV	1.00000	5.30000	.	1.00000	.
107	XE*172	IV	.	8.12000	.	2.00000	3.17000
108	XE*182	IV	4.00000	5.39000	.	4.00000	.
109	XT.1	IV	10.00000	6.48000	.	50.00000	1.40500

TABLE 9.4.2 (cont.)

Comparison showed that site A was less costly than site B which was in turn less costly than site D.

It will be remembered that a system based on site C involved a higher initial expenditure on site preparation than sites A, B and D. Analysis showed that it also involved a higher trip related cost, (although a similar vehicle fleet size), than systems based on the other sites. Therefore once again comparison in cost terms did not require the use of discounted cash flow analysis.

Without exception, transfer based systems involving a particular landfill site offered a reduction in trip related costs when compared to a system based on the same landfill site but not involving transfer. Again, without exception, transfer reduced the required collection fleet size by one vehicle over a non-transfer station based on the same landfill site. However in all cases the saving in trip related costs was outweighed by the period cost involved in running the transfer station. Further, the reduction in collection fleet size was offset by the need to employ a vehicle for bulk haulage. Therefore comparison between transfer station based systems and non-transfer based systems was possible without using discounted cash flow.

The analysis clearly demonstrated that on total cost grounds, a system based on site B alone dominated systems based on sites A, C and D, whether or not a transfer station was involved. The author was not involved in the analysis of systems based on the Coventry incinerator and the private site at Coleshill, (where discounted cash flow analysis was required), but again neither option challenged the superiority of site B. However other factors had to be considered when comparing the

various systems. One issue highlighted by the analysis of total system costs was the fact that there was a distinct pattern in the split of collection costs between districts. Systems with a high overall cost generated a high collection cost for Nuneaton and Bedworth, and a low collection cost for North Warwickshire. Diagram 9.4.1 shows the cost pattern involved.

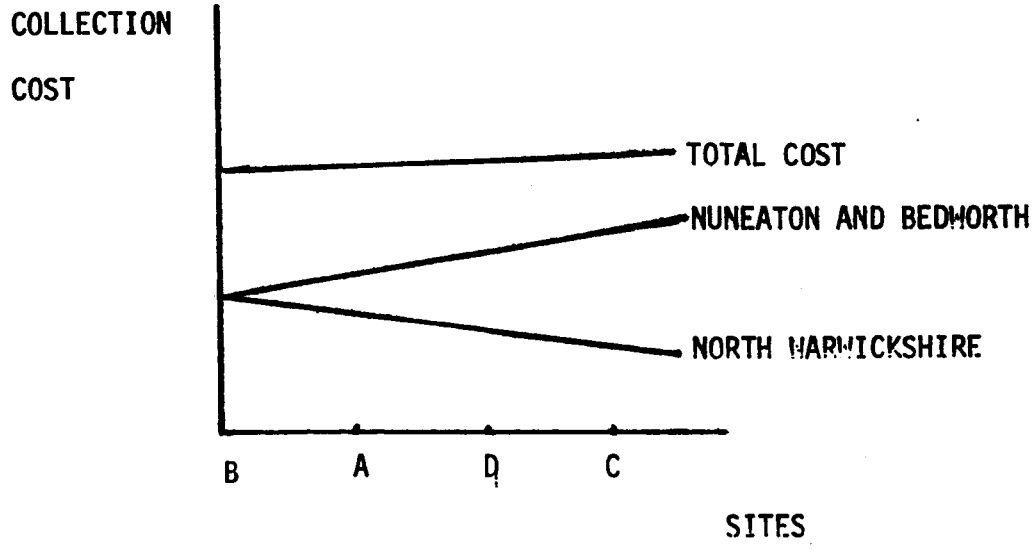


DIAGRAM 9.4.1.

EQUITY ISSUES

9.5 Results and Conclusions

a) The Immediate Problem

The author was not privy to the discussions which preceded a final decision on a replacement for the Blue Lagoon site. Assistance was given to county officers to carry out additional computer analysis, and certainly some model runs were produced by the county without assistance from the author. However it is not known how much importance was assigned to the model outputs in the decision. In the event, the county chose to develop site B without the addition of a transfer station. This decision was of course consistent with the analysis of total system cost.

b) Continuing Model Use

Officers gained considerable experience of using the simple haulage model during the analysis of the Blue Lagoon problem. However because the transfer option proved unattractive they made very little use of the integer programming model. This pattern of use has apparently continued. The author has at various times been informed of continued use of the simple haulage model, but never of any use of the county's mathematical programming package.

It is interesting to note that the most recent information indicated that the system of cost coefficients had been drastically simplified. Effectively system comparisons had been reduced to a comparison of miles travelled.

c) Conclusions

The mathematical models developed were used by and for county waste disposal officers in the analysis of the Blue Lagoon problem. Furthermore the simple haulage model at least has continued in use in one form or another. However there were two reasons for offering assistance to Warwickshire, certainly to assist with a piece of analysis, but also to collect evidence related to the hypothesis sets developed in this thesis. The examination of this evidence in the context of the hypothesis will be carried out in the next chapter.

10.0 DISCUSSION OF EVIDENCE

10.1 Chapter Outline

a) The Purpose of the Chapter

Chapters 6, 7, 8 and 9 detail the findings of the evidence collection activities undertaken during this research. This chapter draws the information together and uses it to determine which elements in the hypothesis sets described in Chapter 5 are the most useful. It must be emphasised that the aim is to form conclusions about the way things are rather than to make recommendations about what should be. The task of making recommendations will be left to Chapter 12, the final chapter in this thesis.

It may be that others will argue that the available evidence supports conclusions different to those presented here. Because of the form the evidence takes, such disagreements are certainly possible. However any such disagreements should be of a lesser degree than those between the orthordox and alternative views about the management process which were identified in Chapter 3 for, the lack of a record of what actually goes on in local authorities so bemoaned by Dearlove (1979) has now been partially remedied. Legislators and participants in the management process can now examine a set of evidence which relates to the practice waste management analysis and planning in several authorities.

b) The Structure of the Chapter

Chapter 5 identified four major groups of hypotheses. These dealt with the form of the analytical process, the consequences of the separation of

collection and disposal for this process, the impact of the process on local democracy, and the extent to which different types of authority differ in these areas. Each of the first three hypothesis groups will be dealt with in a separate section of this Chapter. The fourth, the extent to which types of authority differ will be referred to in these three sections as and when seems appropriate. Chapter 11 will summarise the conclusions reached with regard to all four hypotheses groups.

10.2 The Analytical Process in Operation

a) Existence of an Analytical Process

The interview evidence clearly indicates that officers involved in waste management feel that planning is a legitimate part of their activities. Further, officers in all the counties contacted claimed that a planning activity was going on and that they saw it as an objectives orientated activity. That is to say they saw themselves as trying to achieve a desired future state and not just as responding to present problems. This view of the kind of analysis being carried out is supported by the form and content of many of the publicly available waste disposal plans which the Control of Pollution Act brought into being. In these plans there is typically a clear statement of objectives and an attempt to classify strategies and technologies as consistent or inconsistent with these objectives.

Despite this unanimity of response, some officers had difficulty in identifying what their planning activity consisted of and when it took place. Counties, C,F, and G provided exceptions here but for different reasons. On several occasions officers seemed to be confusing planning with their general management/decision making activities. Phrases such as "planning is a continuous activity" were often used, but the idea underpinning the phra:

frequently seemed to be that planning was something that automatically happened whenever an officer sat down at his desk. When officers were introduced to the analysis circle, there was general agreement that the basic idea corresponded to their view of planning. However different officers tended to emphasise different stages of the circle as in some sense the crucial part of planning.

Although the evidence for an ongoing planning activity was often difficult to discern, the counties contacted during the interview phase of the research, and Warwickshire and Lancashire also, could all point to evidence that analysis had led to a plan being produced at some point in the past. Local goverment reorganisation often seemed to have been the event which inspired the activity, although the Control of Pollution Act had also generated its share of planning events. However it does not seem reasonable to blame the Control of Pollution Act for the view that planning is a once off, or spasmodic activity. Indeed the Control of Pollution Act, with its emphasis on a repetitive survey and forecasting activity appeared to be a major source for the idea that planning should be a continuous process. Where there was an absence of evidence of a continuing activity two factors seemed to be involved. Firstly the view that planning involved the development of a strategy which should be adhered to like a blueprint, appeared to be present. Shire county B and metropolitan county E were the prime examples of this. Secondly several counties appeared to be in the situation of having more than adequate resources to allow the chosen waste management strategy to continue unimpeded. Where the latter phenomenon was present, the activities identified in the analysis circle seemed largely absent. Where only the former was present, attitudes to planning appeared ambivalent. This was the case in county B and county E. Officers in country B expressed the view that they had planned and it had not worked, while officers in county E held that only very short term planning was possible.

In conclusion, there appeared to be a concensus that planning should take place and that it should proceed from a consideration of ends to a consideration of means. However, there appeared to be a lack of a concensus about what was involved in planning.

Despite the lack of clarity about what should go on, there was a clear and unanimous view expressed about who should be involved. Planning was definitely seen as the province of the officers. While officers saw it as necessary to contact fellow professionals in other organisations affected by waste management decisions, most notably the water authorities, district officers, councillors and any representatives of interest groups were seen as outside the activity. The idea seemed to be that officers planned and then presented the results of the activity to any interested parties. District officers, councillors at both district and county level and interest groups were seen as hurdles to be overcome rather than as partners in the process. During the interview phase of the research, particular attention was directed to discovering the role of councillors in any analysis/planning activity. Officers' views about councillors were recorded as was any participation in the specific activities covered by the analysis circle. However despite all this, it had to be concluded, that councillors were not involved in the analysis process underpinning waste management decisions. They appeared as outsiders who had a power of veto, but one which was seldom exercised. It was argued by officers, that when that power of veto was exercised, it was due to either bad handling of the situation by officers or because of some issue unrelated to waste. County G provided an example of the impact of a non waste issue; a preference on the part of councillors for running down the labour force directly employed by the council.

It is possible to argue that councillors did not participate because they felt that they could have most effect by adopting the role of an outsider. However there was no evidence that councillors had made a decision about the relative costs and benefits of these different ways of affecting the analysis process, and more importantly there was evidence of unwillingness on the part of officers to have them involved. Officers tended to argue that councillors lacked the time and the skills to contribute to their deliberations.

There is then the possibility that councillors and the electorate are suffering agency costs of two kinds. Firstly the non-involvement of councillors may be leading to waste management activities which are not effective in the sense of not putting into effect the wishes of the community. Secondly the waste management activities may be inefficient in the sense that too many resources are being directed to the waste management problem. This second type of agency cost is of course the kind identified by Chapman (1978). If we take one aim of the Control of Pollution Act as being to increase recycling activity by local authorities, and identify this with the wishes of the community, then there is evidence that officers are not carrying out the wishes of the community and that therefore agency costs of the first type are being met. The attempts to build up banks of landfill capacity can also be seen as evidence of the possibility of agency costs of the second kind. The frequent failure to take into account economic considerations during analysis can also be seen as evidence for the presence of this second type of agency cost.

Haley and Schall (1978) in their discussion of agency costs argue that professionalism on the part of the agent, in this case the officer, limits the appearance of agency costs. However this does not appear to be the case in the local authority situation. Firstly, the relevant profession in the

waste management context seems not to be administration, but engineering. Therefore there is an adherence to standards in equipment provision and operation rather than in methods of management. There is a second way in which the professionalism of the waste disposal officer may generate agency costs. Professionalism involves the possession of a body of skills, in this case engineering skills, not shared by others, and others in this case includes councillors. If analysis requires professional skills then at first sight there is a good reason why councillors should stand apart and accept the judgement of experts. It is interesting to note that in county B and county C, one of the reasons put forward for using an outside consultant, was that recommendations would carry more weight with councillors. However this viewpoint ignores the fact that issues of democracy are involved.

It should be noted that officers' preference for a rational type of planning process may combine with professionalism to exclude councillors, in that rationality can be seen to imply the use of sophisticated techniques and models which only the professionals can understand.

b) The Content of the Analytical Process

It has been argued that the officers contacted during the interview phase of the research felt that a planning activity similar in style to that represented by the analysis circle was appropriate for waste management. These officers also indicated that such a process was being carried out. It is now necessary to look at what exactly was going on in the activity areas identified by the analysis circle. The findings of all three evidence collection activities are relevant here.

Raison d'etre

The analysis circle starts off by identifying a need to answer the question "What business is the organisation in?" Interviews indicated that possibly three answers were current among the English counties. These were that the task of waste management was seen as one of disposal, or as one of reclamation, or as one of waste processing. Counties A, B, C, D and G seemed to have adopted the waste disposal image, while counties E and F emphasised reclamation. However there is a case for saying that officers in county F regarded their aim as that of making best use of waste as a resource. County F should therefore perhaps be classed as a waste processor.

The predominance of the waste disposal image is hardly surprising. This is after all the term typically used to describe the waste management task, and historically this is the way in which the task has been carried out. However there is a case for saying that the Control of Pollution Act with its emphasis on reclamation aimed to change all that. Certainly, officers in counties C and G, identified the Control of Pollution Act as a reason for considering reclamation, even though little could be done about it. The Control of Pollution Act did not however appear to be the major reason behind the adoption of a different image by counties E and F. These two metropolitan counties did not have the tipping capacity available to operate a simple landfill policy and consequently had been forced into the use of expensive and unreliable incinerators. They were therefore in a position to consider a wide range of alternative methods of dealing with waste without running the risk of increasing the cost of the waste management operation. In this sense the recent history of these two counties allowed them a degree of freedom which other counties did not share. However it should be noted that counties E and F had not chosen/been able to use their freedom to

develop an entirely new pattern of operations. Incinceration still featured to a large extent in their operations when they were contacted. There appeared to be two reasons for this. Firstly, reclamation technologies are largely untried. Secondly, to paraphrase a view expressed by several officers, replacing an incinerator by something less expensive to operate will elicit not congratulations but a query as to why the incinerator was built in the first place. The basic idea expressed here that sunk costs are not seen to be irrelevant appeared on several occasions during the interviews. Indeed several officers, particularly in county G indicated that the relevance of sunk costs was a feature of their analysis of alternatives.

All the counties contacted during the interview phase of the research indicated that there were constraints on the way in which they pursued their overall objective. The cost of the waste management operation featured in the constraint set of each county. The view taken by officers in Lancashire and Warwickshire supports the idea that this constraint is important as does the importance assigned to the financial constraint in the questionnaire responses analysed in Chapter 6. Another constraint identified by all the officers interviewed was the need to take into account the environmental impact of any waste management operation. Again a similar concern was identified by the officers involved in the Lancashire and Warwickshire studies and by the respondents to the county survey.

A final constraint which should be mentioned is the need to build flexibility into the waste management system. Officers in counties B, C, D, E, F and G all mentioned this constraint during interviews. To many of the officers concerned flexibility seemed to involve an ability to respond to changed circumstances. This was certainly the thrust of the comments of officers in counties C, E and G. However others seemed to identify the

concept with an absence of need to respond. This appeared to be the case in counties B and F. Certainly, officers' comments about flexibility were confused and it therefore seems useful to impose some structure on them. One important strand of thought was clearly the idea that flexibility involved the ability to change and respond. However certain comments indicated that this ability to respond was second best to building into the waste management system an ability to cope without need of change. To some extent this seemed linked to the idea that planning and analysis involved creating a strategy blueprint which would hold however external circumstances changed. It seems useful to identify this absence of need to change what has been done with the concept of robustness(1). Therefore in what follows it is necessary to keep in mind that the distinction between the ideas of flexibility, the ability to change the waste management system, and robustness, the ability of the present system to cope without needing to be changed, while present in the comments of some officers was not expressed in these terms. They tended to use flexibility as a catch all term.

As has been indicated, there was no pronounced councillor involvement in establishing the overall aims of the waste management operation. Indeed it was difficult to point to any time at which there had been serious discussion of the nature of the waste management function. Only in the case of county E could officers point to a period in time when there had been internal debate about what approach to waste management should be adopted. In this case, officers had taken the initiative and gained councillor consent to the idea that disposal without some attempt at reclamation should be avoided. The widespread absence of consideration of an organisation's mission is not unusual. However the management literature in general has argued that this lack of consideration can be a source of problems.

Measures of Effectiveness

Evidence from the interviews and from the Lancashire and Warwickshire case studies indicates that little consideration was typically given to the problem of how to measure cost or environmental impact or flexibility in general terms. Indeed the absence of relevant measures of effectiveness is the major reason for questioning whether county F was in fact operating as a waste processor.

In general officers could identify ways in which cost or various dimensions of environmental impact could be measured, but they did not appear to have given much consideration to the question of the validity and reliability of the measures. Only in the case of flexibility/robustness, perhaps because of the novelty of the concept, was there evidence that a debate about measurement had taken place at a general level. For example officers in county B had concluded that although robustness was desirable, they did not know how to measure its presence and those in county F had concluded that robustness involved using a mix of technologies. While the concept of robustness did not feature in the comments of county D, the desire to establish a large landbank of unused tipping capacity seemed to reflect it. In passing, the case of county D makes it clear that robustness can be achieved by over provision of resources as well as by other means.

Officers in county D did discuss flexibility and indicated that they had concluded that its presence could be identified by an absence of capital expenditure. Underpinning this measure seemed to be the view that a record of financial prudence would strengthen the hand of the officers in requesting capital funds if a change in circumstances should make this

necessary. A similar view also seemed to be present in county G. Officers in county E however saw flexibility as something which could be built into a facility. Their measure of flexibility came down to the number of alternative uses to which a structure could be put. To a certain extent therefore they saw flexibility as something brought about by increased capital expenditure.

The comments of officers in county D about their desire to establish a landbank also cast some light on one of the recurring themes of local government operation, whether or not to involve the private sector. Officers in county D argued that to ease site acquisition problems they were willing to allow a site to be owned and operated by a private contractor. However they also stated that for reasons of security, they did not plan to put themselves entirely in the hands of the private sector. Clearly they did not see themselves facing a market in which suppliers of void were competing for their attentions. Therefore they did not equate a degree of privatisation with the generation of competition but rather with the establishment of a potentially troublesome monopolist.

County B to some extent is an exception to the rule that measures of effectiveness were not discussed at a general level. In this case the measure cost per tonne was seen as particularly important because of the attention directed to it by councillors. Officers however argued that it was not by itself sufficient to be a valid performance measure.

It is easy to see why only limited attention was being given to establishing measures of effectiveness. Basically it is difficult to carry out the task in a vacuum. It is easier to wait until a concrete opportunity is being considered and then identify measures of effectiveness. However there are costs involved in proceeding in this way. Firstly, even if the search

for appropriate measures of effectiveness takes place before any evaluation of the option under consideration, it will be haphazard and coloured by short term considerations. Secondly it will typically be carried out in a hurry since the key issue will be whether or not to adopt the alternative, not how to evaluate the alternative. For both these reasons, the activity will probably generate relatively few measure of effectiveness, and the virtues of those that are generated will probably relate more to measurability than to validity. There is a final reason why consideration of measures of effectiveness should be divorced from consideration of an immediate opportunity. This is because typically what will occur is a search among the perhaps irrelevant outputs of an inherited evaluation process. In effect evaluation and selection will to some extent already have taken place to generate a specific alternative for consideration. The criteria involved in this initial activity will remain implicit and unchallenged.

Perhaps the clearest case of this phenomenon of handing over to someone else the task of establishing measures of effectiveness, is provided by county C. In this case, the outside consultant brought in to carry out the planning activity was charged with the task of establishing measures of effectiveness. However it may be argued that in this case the nature of the planning activity to be undertaken was so constrained that this did not matter.

Forecasting

The responses to the question about anticipated life of tip sites which was contained in the questionnaire sent to English counties, seemed to indicate that officers felt capable of generating forecasts of waste

quantities. While the field studies in Warwickshire and Lancashire offered support for this view, they failed to identify any well established forecasting activity. Indeed both field studies indicated that county officers had relatively poor information about the quantities of waste they were currently dealing with let alone about quantities they would have to deal with. The field studies in fact indicated that county officers were simply monitoring the amount of landfill capacity left unused and were prepared to translate that historical data into a forecast of when a new tip site would be needed. Typically the translation mechanism seemed to be an assumption that past rates of tip use would be continued into the future.

As far as additional forecasting tools are concerned Lancashire staff had available a simple rule for translating population into waste quantities. This provided Lancashire staff with an ability to predict the consequences of new housing developments for example. No similar rule of thumb was put forward by Warwickshire staff even though such a rule would have been most useful. Therefore the assumption must be that such a rule was unavailable in Warwickshire. It is interesting to note that most of the attempts to analyse the Warwickshire and Lancashire situations under different assumption about the amount of waste the systems would have to deal with were carried out by the author. The viewpoint held by officers seemed to be that "no change" was a satisfactory picture of the future.

Overall then the conclusion drawn from the two field studies must be that officers were attached to a subjectively produced forecast of no change and that the production of the subjective forecast was not a well developed process.

The survey gave no information about other items which counties might have been forecasting. Furthermore, the two field studies did not identify any other items. However, by implication they did identify either an absence of a forecast or another no change forecast. Officers in both Lancashire and Warwickshire felt able to develop disposal facilities which would be shared by two or more districts. There was no concern shown for the possibility that further local government reorganisation might occur and separate a district from its disposal facility. During discussions it became apparent that the possibility of further reorganisation was not being considered.

There is no doubt that a more formal subjective waste forecasting exercise could have been set up in both Lancashire and Warwickshire. Indeed there was sufficient data on waste amounts in Lancashire to indicate that a simple objective forecasting system could have been established also. The waste quantities might have had to be measured in peculiar units, vehicle loads or dustbins perhaps, but something could have been done. Officers however had not gone beyond the monitoring of rate of use of tip space. Furthermore no other forecasting activities could be discerned.

The interview evidence tends to support the idea that little forecasting activity goes on in the English counties. This is despite the emphasis on waste forecasting in the Control of Pollution Act. Officers contacted were by and large prepared to state what their view of future developments was but could not identify clearly how they came to hold that view. No objective forecasting exercises were found, and nor were any formalised subjective forecasting activities. All the Control of Pollution Act appeared to have done was to elevate the status of data collection

activities, particularly those related to industrial waste. Even so the counties contacted had a limited knowledge of the current amount of waste which they dealt with. A lack of on site weighing equipment contributed to this.

The lack of knowledge about current and anticipated waste quantities was common to all the counties contacted and tended to be accompanied by a similar lack of knowledge about waste composition. In fact, in most of the counties contacted, waste composition was even more of an unknown than waste quantity. What did however vary between counties was the degree of concern expressed about this lack of information about waste quantity and composition. The shire counties by and large were unconcerned. The argument seemed to be that the strategy of landfill, which was the preferred one, could cope with substantial variations in waste quantities, and that waste composition was irrelevant. It is interesting to note that even in the case of county B, where the preferred landfill strategy was causing problems, there was no concern about future waste quantity. The idea seemed to be that once the county was able to cope with the current flow of waste, it would automatically be able to cope with waste in the future.

There was a greater concern about the lack of information about waste quantity and waste composition in the metropolitan counties. This seemed to be because the emphasis on some form of treatment prior to landfill generated an upper limit on throughput which could not be quickly varied, and because the technologies used tended to be more dependent on a particular waste composition than landfill. County G had attempted to cope with its lack of knowledge about future waste composition for example by designing its reclaimation plant to be able to cope with a wide variety of waste

compositions. However officers in county F, which was faced with a similar problem, simply acknowledged the dependence of their planned reclamation activities on a particular pattern of waste composition and expressed concern about their lack of knowledge of future composition. County G had responded to the throughput constraint by producing what officers acknowledged was in their opinion an inflated forecast of future waste quantities. The approach seemed to be to cope with uncertainty by catering for the worst possible case.

This attempt to cope with uncertainty by overprovision of resources has in fact been seen before in other counties. Essentially those counties trying to build robustness into the waste management system by developing a landbank can be thought of as doing exactly the same thing. While the approach is crude, there is an important idea here, that planning can in some sense be a substitute for forecasting.

The interview phase of the research confirmed the absence of forecasting activities in general rather than just those relating to waste quantity and composition. However it also identified on the part of at least the metropolitan counties a desire for particular additional forecasts. These counties were all interested in the market for reclaimed materials. Indeed it can be argued that by carrying out an assessment of the local market, counties E and F had already begun forecasting in this area. The requirements of county G for additional forecasts will however be emphasised here since they provide insight into the way in which forecasting was viewed. Officers in county G expressed an interest in forecasts of prices for scrap metal. However on being told that some imprecision was

inevitable in such forecasts the officers responded by saying that in that case they might not be able to make use of them. Quite clearly they saw forecasting as a way of removing uncertainty rather than of identifying uncertainty. Something of this same line of thought can be seen in the comments of officers in Lancashire and Warwickshire and the other counties contacted during the interview phase of the research. For example the emphasis on short term activities by officers in county E can be seen as an unwillingness to explore an uncertain situation, as can the adherence to a no change forecast by staff in Warwickshire and Lancashire. This view of forecasting can lead to two unfortunate consequences. Firstly it can lead to forecasting being viewed as impossible, because there is no way of characterising the future without admitting uncertainty. Secondly, it can lead to forecasts being presented and used without acknowledgement of the uncertainty inherent in them.

This view of forecasting as the search for certainty may go a long way to explain the absence of a forecasting exercise in the English counties. In turn this may explain the tendency towards over provision of resources which has been noticed. Whatever the reason for it, the absence of virtually all forecasting is surely a cause for concern.

Strategy Generation, Evaluation and Selection

There is a strong case for saying that the strategy generation process in the counties contacted revolved around the scanning of technology journals by officers. With only minor exceptions strategy and technology were seen as synonymous. One function which the Control of Pollution Act

appears to have served is to ensure that reclamation at least appears among the initial set of technologies being considered. However the evidence supports the view that in most cases its presence is merely a token one and that evaluation processes are loaded against it.

It is reasonable to characterise the evaluation/selection activity as starting from a consideration of the feasibility of landfill without pretreatment of waste. Landfill is generally regarded as the least cost method of waste management. If such a strategy is feasible, it will typically be adopted. The shire counties which were examined demonstrate this. Only if landfill is not feasible will an alternative be sought. Further if landfill without pretreatment is not feasible, then at very least, the extent to which alternative technologies use up available landfill space will be a key consideration in the evaluation/selection process.

Even in the case of county F, the supposed waste processor, the availability of landfill was a key consideration. Of course, the waste processor philosophy does not discount the use of landfill. However the availability/ unavailability of landfill did appear to hold a more central place in officers' deliberations than might have been expected.

Answering the question of whether or not landfill without pretreatment is feasible is not as simple as it might appear. Counties B and D provide evidence of how difficult it can be. Officers in county D were told by an outside consultant that the strategy was not feasible, but by giving attention to the process of site aquisition, made it feasible. Officers

in county B had decided the strategy was feasible but had been unable to carry it through. The experience of county D indicates that a view of geological and technical feasibility can be more useful than an outsider's view of what is administratively feasible, but the case of county B indicates that a consideration of geological and technical considerations is not in itself sufficient. The negotiating skill of officers, and the extent to which other elements in the county administration will support the landfill policy can be crucial. This point was emphasised by officers in county G as well as by those in county B.

Only when the landfill option has been discarded do officers appear to give consideration to other waste management technologies. Comparison of alternatives then appears to proceed, at least in the case of disposal options, by using simple tables of publicly available data on crude cost coefficients, compaction rates and pollution levels. However as has been said, volume of residue seems often to be a key consideration; the need to dispose of whatever residual is left after treatment or reclamation must always be taken into account. Because of the emphasis on publicly available data, issues such as the validity and reliability of the figures which are presented seem to be ignored. The metropolitan counties provide clear examples of this. As can be seen from the table prepared by officers in county F, the history of incinerator breakdown rates and repair costs, with which officers in the metropolitan counties are familiar from their own operations, did not feature significantly in the set of data used to describe the incineration technology.

On the basis of such a table of data, selection of a technology is carried out by officers. It should be noted that in doing this they conform to the view of their role put forward by Wilson (1977). The table of data and a recommendation tend to be presented to councillors who are faced with the choice of reviewing technical data and questioning the advice of their technical experts or of simply accepting the recommendation.

Where does reclamation feature in all this? Because of the emphasis on the narrow definition of the community whose costs are seen as relevant, and because of the emphasis on relatively short run costs, there is no way in which reclamation can appear for consideration until the possibility of landfill has been discounted. Once landfill has been discounted then a range of factors come into play. There may be a preference for a reclamation activity such as was expressed by officers in county E. This led to the inclusion of simple metal extraction and the development of a refuse derived fuel. The role of recent history in demonstrating the acceptability of the strategy on cost grounds has already been emphasised. Another possibility is that reclamation is introduced as a means of introducing flexibility into a strategy as happened in county F. Again this involved the development of a refuse derived fuel. A final possibility is that reclamation of heat energy may be seen as a way of improving the economics of disposal by incineration. This was the case at one point in time in one area of county G.

This last example deserves further consideration, since reclamation activity was introduced apparently on the basis of a formal quantitative evaluation of the discounted costs and benefits involved in the activity. In fact the evaluation was based around highly inflated forecasts of waste quantities likely to be generated in the area and overoptimistic assess-

ments of incinerator reliability. It has to be questionable whether this particular form of reclamation would have been considered viable if sources of uncertainty impinging on the evaluation, amongst which was the then impending local government reorganisation, had been taken into account. The introduction of a reclamation activity on the basis of a discounted cash flow analysis is unlikely to be seen again in the near future. This is not because the experience of county G acts as an awful warning, although this may be one factor, but because the way in which discounted cash flow evaluations are carried out discriminates against the acceptance of reclamation. There are two reasons for this. Firstly, during the early years of a project the benefits from reclamation have more to do with national policy than local benefits. Therefore an analysis which takes into account only local costs and benefits will emphasise costs and minimise benefits. Secondly, in the later years of the project, local benefits are possible but they are dependent on the price of reclaimed metal inflating at a faster rate than other cash flow elements involved in the appraisal. However advice from the DOE to counties emphasises that the assumption of a common inflation rate for all elements in a discounting exercise is reasonable. In this case of course the potential value of the reclamation exercise is removed. Therefore it appears unlikely that reclamation will come to be a major activity within counties in the near future. This is of course not to deny the possibility of peripheral activities where a commercial organisation takes on the role of instigator and sponsor.

In what has been said so far, the key role of officers has been emphasised. This served the purpose of highlighting the absence of a contribution from councillors. However two reservations must be made. Firstly, the heavy emphasis in evaluation on crude cost data means that selection

is not a major task. Therefore the analysis in fact lies out of the hands of officers. This task is in effect devolved to the providers of the cost data whoever they may be. It should be emphasised that in many cases they may be the builders of the disposal and reclamation plant being considered. Secondly, the experience of county G shows that officers can have their recommendations overturned by councillors. Officers in county G had effectively completed the preparation of a plan suitable for presentation to the DOE when councillors imposed a new strategy which involved closure of incinerators on them. The councillor input reflected a change in the political composition of the council and a new enthusiasm for handing over certain council operations to the private sector.

So far the emphasis has been on the approach taken by officers to technology selection. This reflects the extent to which strategy and technology are seen as one. However there were indications in some counties, particularly county F of a broader view of strategy. Certainly in this county there was an attempt being made to create a market for a refuse derived fuel, and there was an indication that some effort was being put into an attempt to put producers of waste and potential users of waste in touch with one another. The industrial waste survey provided a data base to support this activity. Since, as a result of the Control of Pollution Act, many counties have available the results of such a survey, this attempt to influence the magnitude of the waste flow a county has to deal with may appear elsewhere.

Alternative Generation, Evaluation and Selection

All three of the evidence collection activities are relevant to the discussion of this topic. To begin with the survey activity generated responses indicating that a substantial proportion of counties had

experience of using advanced evaluation techniques; it will be recalled that 63% of the responding counties reported experience of using management science techniques. Furthermore there was some suggestion that metropolitan counties were more likely to be technique users than the shire counties. However the survey response was not totally supportive of the view that management science techniques were being successfully used by counties. It must be remembered that there was an indication that such use tended to be associated with a view that data was inadequate for decision making. The survey response also indicated that a finite, rather than infinite, feasible set approach was potentially most relevant to this stage of the analytical process in that there appeared to be restrictions on the availability of landfill sites.

The interview evidence in fact indicated that the task of deciding on the number and location of facilities necessary to put a particular strategy into operation was less likely to involve application of management science techniques than the survey evidence seemed at first to suggest. In terms of landfill site development, issues of availability appeared to dominate evaluation and selection in several counties. The metropolitan counties and shire county B all demonstrated this, as did shire county D to a lesser extent. Where a significant use of quantitative techniques was evident or seemed likely to occur, this tended to involve the use of an outside consultant rather than county staff. County C provided the clearest example of this, although counties B and D provided supporting evidence.

The two field studies confirmed the appropriateness of the finite feasible set approach and also demonstrated some of the reasons why officers had difficulty in making use of modern management science techniques. These related to a lack of familiarity with computer based methods, and a lack of relevant data. It should be noted that the field studies did not indicate that these problems could easily be overcome. In the case of the data problem in particular there were major organisational and attitudinal barriers to be coped with. In passing, a query must be raised about how other outside consultants, who attempt to use quantitative techniques, cope with the lack of data. It should be remembered that the survey response indicated that absence of a data set was probably not confined to Lancashire and Warwickshire. There are several ways in which consultants could respond to a lack of data. For example LGORU appears to make use of a composite data set based on several counties. However it does not appear that officers in sponsoring counties are told of the extent to which the data fits their particular situation. Officers in county C were specifically asked how well the LGORU models performed in the sense of providing reasonable figures for current operations. They stated they had no knowledge of this information and indeed the concept of model validation appeared unfamiliar to them.

The three sets of evidence together seem to support the following conclusions. Firstly that site identification involves officers in developing a detailed knowledge of county geography. Some counties had made use of airborne surveys to assist officers in developing this local

knowledge. Secondly, that site availability is not uniform between counties or even within a county. Some areas tend to be well endowed others less well endowed.

Thirdly, the evidence supports the conclusion that in the absence of an input from an outside consultant, modern management techniques and the use of computers are unlikely to feature in the evaluation and selection process. This reflects a lack of expertise on the part of the officers involved and a lack of relevant data. As mentioned earlier it seems that this lack of data may only become apparent when officers try to set up an evaluation process. When measures of effectiveness are not established and analytical aids with large appetites for data are not in use, available data sets are not seen to be inadequate. There is something of a Catch 22 situation here. Until data are available it is not worthwhile introducing advanced quantitative management techniques and until such techniques are introduced the absence of data will not be apparent.

Fourthly the evidence indicates that where any form of quantitative evaluation is carried out by officers it is typically based on crude cost figures. Staff in Warwickshire and Lancashire for example indicated that in the past they typically calculated capital cost and first year running cost. Later contacts indicated that both counties were using distance data as a proxy for operating cost figures, and officers in county C also indicated an intention to try this. Even in the case of county G where the alternative evaluation phase did tend to involve a discounted cash flow analysis, the cost figures tended to be very similar to a combination of capital cost and first year running cost, because inflation tended to be ignored. Fifthly, the relevant community for

cost calculation purposes tended to be the county. County G took this to extremes by excluding benefits accruing to districts from consideration. However, this was exceptional. The tendency was to try to recognise district costs either by explicit modelling, as was done in the Lancashire and Warwickshire field studies and also in county C, or to make use of compensation formulae. Counties A, C, D and Warwickshire made use of these. No county appeared to try to take into account cost reductions due to round reorganisation. This is perhaps not inappropriate behaviour given the comments made by district staff during the Lancashire field study.

Sixthly there is evidence that environmental issues tended to be introduced as a method of reducing the number of elements in a feasible location set and in the establishment of operating standards for any facilities. In some cases environmental issues effectively reduce the number of feasible options to one. In this case evaluation tends to be superfluous! Officers in county D indicated that this was a commonplace situation. Finally, it appeared to be the officer groups which identified possible sites, carried out the evaluation and then made recommendations. It is possible to argue that given the unstructured nature of the evaluation, officers may have been taking into account the wishes of councillors in an informal fashion. However there is no evidence for this. The pattern seemed to be of officers making a recommendation and then bowing to political will only when they could not manage to divert it. The rationale provided by officers in county B for welcoming the activities of an outside consultant is indicative of this. Overall the picture was of councillors having to respond to officers' analysis rather than initiating it or participating in it.

The consequences of this pattern of evaluation are simple to see. Firstly, there is the obvious possibility of expenditure being higher than necessary, given the limited way cost considerations were taken into account. Secondly, there is the obvious possibility of district costs and benefits being misrepresented or ignored. Finally the haphazard nature of the decision process makes it difficult to ensure that alternatives are evaluated consistently, and in such a way as to reflect overall objectives. The remedy is less clear cut. It has been argued that remedying data deficiencies is not an easy matter and that using an outside consultant may simply mask the data problems rather than remove them. It will be argued later that using an outside consultant can in fact introduce additional problems and that this could also be true of an increased use of modern management techniques should it prove possible to introduce them.

Monitoring Implementation

To some extent the survey and the two field studies, although they did not specifically address the question of whether implementation monitoring went on, gave a good indication of what the interview phase of the research would find. After all monitoring implementation involves comparing anticipations with actual data, and survey and field study both indicated that data collection was limited. Unsurprisingly then, the interviews generated no evidence of officers monitoring specific facility performance, let alone total system performance to see whether anticipated performance levels had been met. Certainly there were examples of data being collected and noted, as opposed to just being filed, but this data did not seem to impinge on whatever evaluation took place of the next, similar alternative

under consideration. One of the officers involved in the Lancashire field study commented that in fact an individual officer was unlikely to be involved in more than one major capital investment during his stay in any one authority. Therefore, to some extent, how the facility performed was of limited interest. More important was to see construction through so that relevant job experience could be offered in the next job application. While this officer was obviously expressing a personal opinion, it did appear that the waste disposal officers who were identified as being involved in planning/analysis activity during the various stages of the research faced relatively poor career prospects if they stayed within the waste management group in any one county. Therefore there is some possibility, that such officers may be highly mobile.

It may be that the attempts to introduce reclamation technologies in counties E and F, because they are so novel, will bring some kind of post event audit process into being. The fact that the activities have been widely publicised also indicates that this may be so. While there was no official post event audit on the combined incineration/heat reclamation activity in county G referred to earlier, which suffered so many problems, anticipated performance was so widely publicised that several individuals outside the authority were able to carry out a crude form of audit.

While the interview phase of the research did not identify any monitoring of implementation in the sense of post event capital expenditure audits, it did identify a similar type of activity at the strategy level. All counties appeared to take note of barriers which appeared between recommendation and facility acquisition, whether these related to councillors, other council departments or groups outside the local

authority such as environmental interest groups and the water authorities. Most counties seemed to have recognised the power of the water authorities to be so great as to warrant involving them early on in the discussion of any activity which might fall within the bounds of their concern. The survey activity of course provided evidence of the importance attached to the activities of the water authorities. Furthermore several counties had taken account the extent to which the waste disposal function relied on the good offices of other parts of the county administration during the process of site acquisition. In county B, for example a special committee had been set up to cope with this problem, and of course officers in county G had expressed similar concerns.

It can be concluded therefore that the interview phase of the research did provide evidence that officers were concerned to ensure that planning and analysis activities had consequences for action. However it must be acknowledged that the case of county B indicates that officers could have difficulty in distinquishing between an implementation problem and an infeasible strategy, and that something of the same situation might have been present in county G.

c) The Planning Environment

It appears then that the desire for an "ends to means" type of analysis process on the part of officers has not led to the development of many of the activities which the analysis circle associates with that type of analysis. This is not to say that the activities do not exist; more that they are often implicit, unstructured and make little use of the variety

of analytical aids which are available. At various points it has been indicated that the environment in which a particular group of officers finds itself can have an impact on the type of strategy which is adopted. It is also the case that the nature of the environment can define certain activities which should form part of a planning process. This section therefore serves to emphasise the characteristics of the environment which appear significant.

Firstly the fact that disposal and collection are separate activities is a key element in the environment. It puts a barrier in the way of data flows and makes it difficult for officers analysing potential disposal decisions to take into account any collection consequences. Secondly counties differ dramatically in the amount of resources they have at their disposal to cope with waste. Several authorities among those contacted inherited on reorganisation adequate tipping capacity, actual or potential, to allow a landfill strategy to proceed unhampered. Other counties did not. In the case of these counties the boundaries defined by local government reorganisation created a demand for disposal capacity, but did not provide landfill capacity to meet the demand. It should be pointed out that although the metropolitans, perhaps with the exception of South Yorkshire, suffered this fate, a simple shire/metropolitan analysis is inadequate. The survey evidence and the case of county B certainly indicate that there are shire counties which are equally under-resourced in this sense. There is another way in which counties differ in the amount of resources available to them. While all counties have the same tasks to carry out, some authorities assign more importance to these tasks than others. So, while it is possible to find authorities which have established

waste management as a separate department, assigned someone of chief officer status to it, and staffed it accordingly, there are others where this has not happened. In the shire counties in particular the tendency seems to have been to place waste management as one function among several under either the county surveyor or county engineer. Staffing levels tend to reflect this subordinate role.

These first two elements in the environment can be seen as a reflection of the existing organisational framework. The third key element in the environment is a reflection of activities which predated that framework. On reorganisation, some counties inherited an existing set of waste treatment facilities. Counties E and G provide good examples of this. Co-operation between pre reorganisation authorities had led to the development of a capital base not shared by other counties. Unsurprisingly this inheritance turned out to be a mixed blessing. The inherited facilities, built as they were when the technology was in its infancy, tended to be inefficient. This meant that a high cost waste management activity was inherited. However, this high cost widened the range of choices open to the new managers since many different technologies for both reclamation and disposal offered the possibility of cost savings.

The discussion so far has centred on the static component of the environment. However another key element of the waste management environment is the uncertainty inherent in it. The fact that many of the officers interviewed spoke of a need to develop a flexible/robust waste management system indicates that the uncertainty in the environment was recognised.

However, the sources of the uncertainty were relatively unexplored and therefore it is perhaps true to say that the magnitude of the uncertainty was unrecognised. The source of uncertainty which officers appeared most aware of was the rate of technological development in disposal and reclamation. Few officers were prepared to forecast what might or might not be feasible over a ten year time horizon. There was far less concern about the quantity and composition of waste the technology would have to deal with. Indeed in the case of waste quantity, officers seemed willing to commit themselves to a forecast of little change over a ten year horizon. It is tempting to associate this apparent certainty with the statement that at least in this respect, the environment exhibited stability. However the examination of the mechanism underpinning waste generation carried out by Berry (1978) highlights the fact that strong assumptions were being made about resource availability, production processes, attitudes and plans. Furthermore there was little evidence that any care had been taken in producing the forecasts. There is therefore a case for saying that the uncertainty in future levels and composition of waste remained unexplored.

Officers were certainly aware that the decisions of other participants in the environment could affect their operations. Councillors were seen as capable of having an impact, as were environmental pressure groups. However the attention paid to these participants was minimal compared to that paid to the water authorities. Both survey and interviews indicated the importance assigned to these bodies. Officers were also keenly aware that policies on other aspects of the county's operation could have a significant impact. Policy on land use planning seemed particularly important.

Surprisingly, given that local government reorganisation had such a major impact on the collection and disposal function, little concern was expressed about the possibility of further reorganisation. There appeared to be two reasons for this. Firstly, it was seen as so far out of the control of officers that in no way could they be held responsible for the consequences. Secondly, the event was seen as unforecastable and therefore as impossible to consider.

A final aspect of environmental uncertainty should be mentioned. This relates to the absence of data collection and implementation activities. There was a high degree of uncertainty surrounding the extent and consequences of current operations. Issues such as how much waste was being dealt with, and how much the activity was costing were shrouded in uncertainty. Interviews, field studies and survey all confirmed this. It was not the case that pressure of time in carrying out the problem solving activity involved in the field studies caused the data problems. Survey and interview results confirmed their presence. Furthermore, during the Lancashire field study, officers in Blackpool reported that their previous attempts to calculate important cost coefficients had failed also.

The areas of uncertainty which have been described can by and large be set in the context of the analysis of sources of uncertainty found in Friend and Jessop (1969). Issues such as rate of technology development, quantity and composition of current and future waste, and the cost consequences of current operations fall within what Friend and Jessop identify as environmental uncertainty. The impact of water authority decisions, district decisions and policies elsewhere in the county fall under the heading of uncertainty in related areas of decision making, and finally the potential impact of councillors and interest groups constitutes what Friend and Jessop call uncertainty about policy values. Uncertainty about a future re-organisation

could be classed under any heading. However later arguments about how best to respond to uncertainty suggest that it is best classed as environmental uncertainty.

In simple terms the response of waste disposal groups to environmental uncertainty has been to opt for flexibility or robustness or to assume that the future will resemble the past. It is impossible to say which of these two approaches is most appropriate without the extent of uncertainty having been explored. Uncertainty about related decision making areas has by and large generated an attempt to involve other officer groups in the analysis process, however uncertainty about policy values seems to have generated quite the opposite response. Councillors and interest groups have generally been excluded from the analysis process. In this sense the participatory style of planning envisaged in the Control of Pollution Act appears to have developed in a rather one sided fashion.

d) The Analysis Process as an Ideal

It remains to examine how well the analysis process which has been described as operating in the waste management area fits the various descriptions of ideal processes which can be found in the literature. The blocks of hypotheses which were established to deal with aspects of the question of what the analysis process looked like referred to two of these ideals, rational planning and disjointed incrementalism. This section will deal with these as well as others.

Lindblom(1968), the originator of disjointed incrementalism, provides a clear definition of what he considers the rational model to involve. It can be summed up in the following terms. Faced with a given problem, a rational

man first clarifies his goals, values or objectives and then ranks or otherwise organises them in his mind. He then lists all important possible policies for achieving his goals, and then investigates all the important consequences that would follow from each of the alternative policies. He then compares the consequences of each policy with his goals and so chooses the policy most closely matching his goals.

Lindblom and many other writers have identified problems with putting this approach into operation. Firstly, the emphasis on all policies and all alternatives is seen as placing an impossible load on an individual or group; the search activity is immense as is the implied computational burden. Lindblom's more recent writings indicate that it is this aspiration to comprehensiveness which alienates him from this approach to analysis (Lindblom, 1979). A second problem involved in putting rationality into operation which is identified is that it will generate often unnecessary political argument, in that the attempt to make objectives clear will generate conflict between participants,and in that the conflict will often relate to choices which are actually unavailable. A third failure of the rational approach often identified is that it draws too harsh a distinction between ends and means. Ackoff (1979) in a different context also emphasises that means can have aesthetic qualities. Finally, it has also been argued that the pursuit of rationality is value laden, because rationality is often defined in terms of the interests of one group. Smith and May (1980) provide a useful survey of these criticisms.

Lindblom has offered a widely discussed alternative approach to analysis, disjointed incrementalism. Smith and May (1980) identify this approach with

the following stages. An individual when analysing a problem, starts with policies already in force, considers only a limited number of marginal changes in these policies, and evaluates them only in a limited way. This undoubtedly captures the essence of Linblom's antagonism to the comprehensiveness of the rational approach, but is perhaps not fully representative of his views. Lindblom (1979) clearly sees the process described above, simple incremental analysis, as only one part of disjointed incrementalism, which is "a mutually supporting set of simplifying and focusing strategems". His view seems to be that the alternative to rational planning is "strategic analysis", basically anything which short-cuts conventionally comprehensive scientific analysis, and that disjointed incrementalism is one short cut approach. He identifies the set of strategems which make up disjointed incrementalism as including:

- limitation of analysis to a few policy alternatives;
- an intertwining of policy goals and other values with the empirical aspects of the problem;
- a concentration on ills to be remedied rather than goals to be sought;
- a sequence of trials, errors, and revised trials;
- exploration of only some consequences of alternatives;
- fragmentation of analytical work to many participants in the process;

Lindblom's position is then much more complex than that presented by Smith and May.

Disjointed incrementalism has attracted its own set of criticisms. Basically these are that the approach is conservative in that it merely tinkers with

the status quo, unjust in that it perpetuates the views of existing power blocks, and costly in an opportunity cost sense. Again Smith and May (1980) provide a useful synopsis. However it is works such as those by Dror (1964) and Etzioni (1967) which propose further alternatives which are the best known.

It must be emphasised that it is the aim of Dror and Etzioni to attack disjointed incrementalism rather than to support rational planning. The alternatives to disjointed incrementalism which they propose are as much alternatives to rational planning. In fact Etzioni's proposed alternatives clearly falls within the strategic analysis framework supported by Lindblom in that it does not aim for comprehensiveness. Dror's alternative essentially follows the sequence of steps identified by Lindblom as constituting rational planning, while limiting the exent of search and analysis activity at each stage. It is therefore perhaps more a recognition of capacity constraints which should be removed as far as possible than a recognition that comprehensiveness is an inappropriate target. However this reservation about the extent of the divergence from rational planning cannot be levelled against the mixed scanning approach advocated by Etzioni. Here there is an identification of a two stage analysis process with different approaches being relevant at each stage. The first stage involves the examination of policies in terms of values and objectives. The emphasis is on wide coverage but a broad brush evaluation. The second stage covers the identification and evaluation of specific options for putting policies into action. Here the emphasis is on a more detailed evaluation of relatively few alternatives.

Neither of these approaches has been immune to criticisms. Nor are they the only other approaches to analysis which the rational planning versus disjointed incrementalism argument has thrown up. However the mixed scanning approach has attracted support, and taken together they indicate that there can be many different views of what constitutes an ideal planning process.

It must be emphasised that here the search is for a statement which describes what has been found during the evidence collection phase of the research rather than for an ideal which managers should seek to implement. Some authors, for example Smith and May (1980) have argued that much of the debate between the advocates of different ideals stems from a confusion between the use of an ideal as a target and the use of an ideal as a descriptive model. There is no such confusion here. In passing it should be noted that Lindblom would certainly not agree with the conclusion of Smith and May that disjointed incrementalism should be viewed as descriptively accurate but not as a target to be aimed for. Lindblom (1979) clearly states that the model "is and ought to be the usual method of policy making".

Quite clearly, the rational model is not an adequate description of the analysis process which was in operation in the English counties. The interview phase of the research failed to find a single example which could be so described and the fieldwork and the survey indicated that in terms of data availability and organisational arrangements there were major barriers in the way of any such pattern of activity. However the interview phase of the research did not identify any county to which Lindblom's disjointed incrementalism model unambiguously applied.

Certainly, there was ample evidence of simple incremental analysis, but even in counties like A, and D where this approach predominated there appeared to be some evidence of concern for future goals, however crude, rather than for just remedying present shortcomings. In other counties such as E and F the evidence for concern with future goals was quite strong. There is an important point here. Whatever the appearance of the analytical process in terms of the range of activities carried out and the way in which they were carried out, there was no evidence that officers were trying to operate along the lines of disjointed incrementalism, and they certainly did not choose to present themselves as doing so during interviews.

In terms of surface appearances then, the disjointed incrementalism model may seem most appropriate. However these surface appearances do not identify the mechanisms which generate them. It seems most appropriate to say on the basis of the interviews and the field studies that officers have in general only a hazy knowledge of what constitutes a planning activity, and that what knowledge they have stems from various superficial descriptions of the rational model. Their attempts to operate in a rational manner are typically constrained by various factors similar to those identified by Simon (1957) such as extent of knowledge and individual abilities, and the outcome is something which resembles simple incrementalism. However the aim was not disjointed incrementalism and this is reflected in the way in which officers describe what they do (particularly the attachment shown to an Ackoffian view of planning) and in the kind of help they seek when they approach consultants.

10.3 Consequences of the Collection/Disposal Split

a) Are the Two Operations Self Contained?

As far as waste management was concerned the allocation of disposal and collection to different tiers of the local authority framework was the most significant aspect of the local government reorganisation of 1974. Many districts felt aggrieved that they had lost disposal, a function with which they felt well able to cope, and many counties found themselves faced with a task which they were happy to delegate under agency arrangements. However as time passed the agency arrangements were terminated and counties took on the responsibilities of developing and managing disposal operations. However the evidence is that the allocation of collection and disposal to different tiers did not reflect any separability in the disposal and collection operation, and that the separation has generated problems.

The lack of separability is easily demonstrated at the physical level. The two functions are linked by a flow of waste. The collection agency is a supplier and the disposal agency is a receiver. Therefore, total independence would only be possible if the decisions which disposal and collection authorities are empowered to make had no effect on route positions and the quantity and composition of waste flowing along the routes. However this is not the case. A key problem facing many county authorities, according to the survey results, was a need to replace disposal facilities and an inability to locate replacements close to the facilities being replaced. Thus routes must change and inevitably this will affect collection costs. Similarly changes in the collection situation can affect the quantity and composition of waste sent to the disposal authority. Such changes may arise simply because of new housing development, or because of decisions on the part of the collection authority. Officers

in county G recalled that on one occasion a district changed its collection procedures and sent waste to the county incinerators in plastic sacks. This affected incinerator performance adversely and machinery had to be installed to slash open the sacks before they went into the incinerator.

The key point is that in a stable situation where the collection operation presents an unchanging picture to the disposal authority and the disposal operation presents a similarly static picture to the collection authority, the two activities can operate separately. However in an unstable situation this is not the case, and scarcity of suitable landfill sites and technology changes indicate that the current situation is unstable.

b) Implications for the Analysis Process

The fact that disposal decisions can have an impact on collection operations raises several questions about the appropriate form of the analytical process. First of all it raises the question about the constituency which disposal decisions are supposed to benefit. At the simplest level an answer to this question requries only a decision to either take into account collection consequences of disposal decisions or not. However should the decision be taken to include such costs then issues of equitable treatment among several collection authorities can arise. At risk here is effectiveness, but efficiency may also suffer as will now be argued.

A second way in which the separation impacts on the form of the analysis process is that it introduces additional uncertainties into the environment facing county waste planners. In part this is because the collection authorities are independent decision makers. They can change collection procedures if they wish, and as has been seen, this can have an impact on the functioning of waste treatment facilities. As some counties invest in waste reclamation technology which imposes certain limits on waste composition and waste density, the sensitivity of county operations to district decisions is likely to increase.

This uncertainty due to the presence of an additional focus of decision making power is compounded by other types. The disposal authority may find itself cut off from past records on waste quantity and composition and also from current data which could help it in estimating waste flows. Where counties have invested in weighing equipment at sites and have contracted to have waste analyses done, this is of course not a problem. However counties typically do not weigh all, or even most, waste arriving at their facilities. These counties can only have recourse to vehicle counts. In this case access to distrct bin registers might provide information which would allow waste flow estimates to be refined.

More important than the separation from waste flow and composition data is the separation from district cost data. If counties wish to take collection costs into account when they analyse disposal decisions they must have data which allow them to do that. However the districts are the only possible source of that data. This raises several issues:

- can data provided by the districts be trusted?
- how can districts be persuaded to collect additional data?
- how much effort and resources should districts be encouraged to expend on data provision?

The Lancashire and Warwickshire field studies and the survey indicated that there are significant gaps in district data collection procedures for decision making purposes. Furthermore, the field studies indicated that districts can view data provision to counties as not in their own interests.

There is then a strong case for saying that local government reorganisation complicated the situation for an officer wishing to carry out an analysis activity similar to that identified in the analysis circle. There is of course the possibility that some benefits accrue. Lindblom might certainly see some. The reorganisation can be thought of as essentially creating two analytical tasks - so there is the spreading of analysis which disjointed incrementalism involves - each of which can only proceed on the basis of simple incremental analysis.

c) The County Response

As has been said, to some extent the county response to the separation of collection and disposal functions has been to carry out analysis in an incremental fashion. There is certainly no evidence from survey, field studies or interviews that contacts between district and county officers are being used to resolve uncertainties. The survey showed a predominance of informal and infrequent contacts, which the field studies suggest may have more to do with operational problems than analysis. Furthermore there is no evidence that counties were seeking to involve district officers in the planning activities begun in the aftermath of the Control of Pollution Act. The fact that officers in counties B, C and D indicated at various points during interviews that they had good relations with district officers needs careful interpretation. It must be borne in mind

that the county officers did not report ways in which district officers were involved in planning. Rather they indicated that they were seen as people to whom the plan would be shown. Throughout the research there appeared to be tendency on the part of officers to report good relations with district counterparts. (There were of course exceptions to this rule, such as county A). However it was often difficult to establish that there was any content in these relations. The Lancashire and Warwickshire studies certainly seemed to indicate that good relations existed because counties had made few demands on districts. When an attempt was made to collect data, then good relations proved insufficient to generate the required information.

The field studies provide examples of one strategy county officers can adopt, and which some have adopted, to deal with the impact on the analysis process of the separation of collection and disposal. That is to employ an outside consultant to effect an integration. How successful this approach can be is a matter for debate. It is clear that the mere presence of a consultant will not compensate for district unwillingness to provide data or for the fact that data are not collected unless the consultant has a store of relevant data. A second approach which is adopted is the use of compensation formulae. Warwickshire and counties E, D and F made use of these. The formulae measure the extent to which a new disposal site increases the amount of travel by collection vehicles, and multiply excess travel by a cost per mile factor. This amount is paid to the districts by the county to compensate for the inconvenience caused by the shift in disposal sites. The measure of additional distance travelled can be very crude. Typically the distance between an agreed district or collection round centre and the disposal site used on local government reorganisation is taken as normal, and haul distances from the agreed centres to a new disposal facility are compared to it. The formulae were typically established

by negotiation, and may or may not reflect adequately the collection cost consequences of a changed disposal site. However they do provide a simple rule for county staff which allows them to take into account collection costs factors without having to make heavy demands on districts.

d) The Benefit/Cost Balance

The costs of reorganisation have now been identified. They can be classed as falling under the portmanteau heading of managerial diseconomies. They relate to difficulties in establishing controls and to difficulties in responding to the environment to make savings and grasp opportunities. However use of the term managerial should not mask the fact that they fall on councillors as well as on officers. As has been said issues of both effectiveness and efficiency are involved.

The question which must now be examined is whether there have been any compensating benefits from reorganisation. One possibility has already been pointed out. This is that by enforcing a kind of disjointed incrementalist approach to analysis on officers. reorganisation may have brought about better analysis than was common in the pre-reorganisation situation. If this has been the case, it was certainly not the intention of the reformers whose activities moulded the form of the reorganisation. They largely drew their inspiration from the orthodox body of thought described in Chapter 3, and in that body of thought the incrementalist approach was clearly identified as unsatisfactory. However even if the outcome did differ from the intention in such a dramatic way it is a difficult case to argue in the absence of a knowledge of the pre-reorganisation analytical process.

A priori, it would appear that the search for benefits should be more fruitful if it is directed towards economies of scale. The possibility of seizing these was after all a major force behind the reorganisation movement. However, during the field studies and interviews, no officer mentioned the possibility of engineering economies of scale. It seemed more the case that officers viewed their county as being split into a number of areas which had to have their own waste handling facilities, and that therefore issues of scale did not appear. There appeared to be two reasons for this view of the county being held. To some extent physical factors, such as the river network on the Lancashire coast, generated this view. The physical objects could of course be man made as well as natural; the urban sprawl of the West Midlands certainly provides a barrier between North and South Warwickshire for example. However as well as physical factors, county officers seemed to feel that facilities should be located close to the districts making use of them. This feeling seemed to stem from the recognition that long haul in collection vehicles imposed additional costs but also from a recognition that it could be politically difficult to locate a disposal facility, with all its attendant nuisance, in one district for the purpose of handling the waste from several.

This non-physical factor argument is the kind of system wide argument identified as relevant to the issue of scale economies by Tomlinson (1982) and it is perhaps worth emphasising his general argument at this point. This is that at the present there is no adequate methodology for dealing with scale economies. A simple comparison of engineering economies with managerial diseconomies is insufficient. A more appropriate approach

would take into account:

- the fact that there are system wide ramifications of the introduction of a large scale facility,
- the fact that economies may only be achievable if the facility operates close to target capacity, and that therefore large scale facility construction may require accurate forecasting. (The Coventry incinerator may well be a case in point).
- the fact that building up capacity in several small units generates flexibility in that later units need not be built if the situation changes.
- the fact that building up capacity in several small units can allow benefits to be derived from the operation of a learning curve effect.

Overall then the implication is that if economies of scale did stem from the development of large treatment facilities it was more by luck than judgement. There was at the time of reorganisation insufficient data to allow the appropriate scale of the waste disposal operation to be identified. A further point which needs re-emphasising here is that the new boundaries not only established demand but also supply of disposal facilities in that landfill is not uniformly dispersed throughout the country. This implies that economies of scale may well have been masked by the forced adoption of an otherwise unsatisfactory technology simply because of the amount of bulk reduction it promised.

It might be argued that the Warwickshire field study provides exceptions to the rule that officers did not mention scale economies. However the ability to furnish information that average fixed costs declined with throughput according to a step function hardly seemed to warrant this emphasis. There was after all no information available initially about

the behaviour of variable cost elements. Indeed as indicated by survey and field studies, available information seemed insufficient in many counties to support a satisfactory exploration of variable cost behaviour over a wide range of activity levels.

Overall then the most appropriate conclusion appears to be that the presence of economies of scale is unproven, but that there is some evidence for the presence of managerial diseconomies.

10.4 Democracy and The Analytical Process

a) Who is Involved?

The evidence of field studies and interviews indicates that the principal participants in the anlytical process were officers in the county waste management function. There was no indication of significant participation by councillors. They were seen by officers as outsiders to the process who had the power of veto but who could be persuaded not to use that power by careful presentation of officers' recommendations. Officers carried out what analysis was undertaken, and decided when such analysis was required. They also seemed to have the power to define the overall purpose they were attempting to serve. The establishment of reclamation as an overall objective in county E is a case in point. It is possible that officers have been able to adopt this attitude because waste management is mundane and rather technical and therefore not of interest to councillors. Therefore there is no implication in this that a similar situation holds in other areas of council operations. That question has simply not been addressed.

The exclusion of councillors was not compensated for by the involvement of

representatives of community interest groups. The only outside bodies to whom officers seemed to pay attention were their counterparts in the water authorities. Other groups were ignored. Environmental pressure groups for example were seen as hostile and unlikely to make constructive contributions. It was acknowledged however that on occasions the efforts of such groups had led to officers' recommendations having to be reformulated. There was no evidence then of the working of the electoral chain of command theory, with officers responding to councillors who in turn responded to the electorate. Rather the opposite view might be held to be more descriptive with officers instigating policy and imposing it on councillors and electorate. Further there was no evidence of vigorous local interest groups "maintaining a spirit of local democracy". (Richards, 1968, p.154).

The interview evidence was particularly irreconcilable with the view of anything but a crude form of democratic control. While officers acknowledged the ability of councillors to overthrow recommendations, the general feeling seemed to be that such an event reflected parochial political issues which interfered with the development of an appropriate waste management system. The value system which dominated discussion was that of the professional engineer rather than that of the public servant. It was not a case that national interests were supported over county interests or county interests over district interests. More it was the case that officers felt that there were criteria of excellence which took precedence over all others. These were typically seen to be excellence of facility type and adequacy of facility capacity.

This is not to argue that officers were totally insensitve to criteria other than engineering excellence and adequacy of disposal capacity. The possibility of veto ensured that recommendations were generally accompanied by some statement that cost considerations had been taken into account and were

tempered by a recognition of the possibility of extreme public hostility. However the tendency was for officers to try to get things past councillors rather than to involve councillors. Thus there is a case for saying that the form of the analysis process hampered the functioning of local democracy. Further to can be argued that the absence of democracy led to lack of effectiveness and efficiency rather than to their presence. That is to say that effectiveness in a supposedly democratic system can only be present if the population's values and criteria are embodied in the analysis process, and that such values and criteria probably mitigate against excess provision of facilities in terms of both quantity and quality.

b) Models and Model Builders

The possibility of veto by councillors has led some officers to seek validation of their recommendations by outside consultants. In the case of county C it seems reasonable to say that the activities of the consultants were defined so that the viewpoint supported by officers could not help but be confirmed by the consultant's conclusions. However in other cases, it is possible that officers felt that their own standards of excellence would be reflected in a consultant's report, or even that a consultant's report would establish standards for officers. It is certainly the case that several counties used a consultant in the immediate post reorganisation period when they were coming to terms with their new responsibilities. To some extent this second pattern of consultancy use is even more damaging to the democracy of the system, than the first. At least the recommendations sought by officers in county C could be thought to reflect their view of what was politically possible as well as what was technically desirable. However the second pattern of use may involve inheriting from the consultant and from the tools he uses specific views of what constitutes effectiveness

and efficiency. At very least the use of an outside expert tends to project the analysis process as something of a no go area for ordinary mortals and in that sense may hamper councillors and interest group representatives in their attempts to influence what goes on.

It has been argued earlier that a reasonable model of the form of the analysis activity being carried out is that it was an attempt at rational planning severely constrained by understanding, skills and information. The attempt to involve consultants who make use of the full panoply of mathematical model building techniques is consistent with the pursuit of rationality. In the particular case of LGORU, their approach certainly tends towards the comprehensiveness of rational planning. It is interesting to explore the question of why rationality should be prized. There are three reasons which stand out. Firstly, rational planning accords with everyone's intuitive view of what planning should be. This viewpoint is put forward by Faludi (1973) in particular. Secondly it is possible that officers have assimilated notions of rational planning from the content of the Control of Pullution Act, DOE publications and the like. It would not be difficult to interpret these sources as supporting attempts at comprehensiveness and quantification. Finally it is possible that rationality is prized because such planning can be presented as technical and requiring particular skills. In this way it would serve the role of a barrier in the way of would be participants in the planning process. The comment of Wilson (1976, p. 21) that use of a hierarchy of models puts planning in the hands of officers where it belongs, is perhaps relevant here. While it seems possible that Wilson had in mind the rescue of the planning activity from outside consultants, the fact that officers featured as the beneficiaries is interesting.

10.5 Summary

a) Chapter Content

This chapter has related the evidence which has been collected to the orthodox and alternative pictures of the waste management operation developed in the earlier part of this thesis. In order to provide explanations for some of the findings attention was directed to the environment in which analysis takes place. An examination of alternative analysis processes was also provided. This highlighted shortcomings in both rational and incrementalist approaches, both as normative models and descriptive tools.

The following chapter summarises the preceding discussion and relates it to the specific questions identified in the orthodox and alternative hypothesis sets.

NOTES

(1) This is not the way the term is used in the O.R. literature where it is seen as a measure of flexibility.

11.0 CONCLUSIONS: THE HYPOTHESIS SETS

11.1 Introduction

a) Objectives of the Chapter

In Chapter 5 two descriptions of the analytical process in waste management, an orthodox and an alternative description, are presented. Each description is set out as a sequence of hypotheses. These hypotheses (or questions as they might be termed) have been examined in Chapter 10 in the light of the evidence collected. It now remains to summarise the conclusions reached.

b) Structure of the Chapter

There are four pairs of major hypotheses dealing with respectively: the existence and content of the analytical process, the impact of the separation of collection and disposal functions on the analytical process, the impact of the analytical process on the democratic nature of waste management, and finally the existence of differences in problems and responses between different types of local authority. Each pair of major hypotheses consists of an orthodox and an alternative version, and each pair is dealt with in turn in a separate section of this Chapter. Associated with two pairs of major hypotheses are sets of subsidiary hypotheses. All orthodox subsidiary hypotheses have an alternative version. However some alternative subsidiary hypotheses do not have an orthodox counterpart. Thus although there are alternative subsidiary hypotheses 1.4, 1.8, 2.3, there are no orthodox subsidiary hypotheses

numbered 1.4, 1.8, 2.3. Where a matched pair of subsidiary hypotheses exists the pair is dealt with in a separate subsection of this Chapter. Alternative subsidiary hypotheses 1.4, 1.8, 2.3 are also allocated separate subsections. The final section of this Chapter presents an overview of the conclusions which have been reached.

11.2 Existence of an Analytical Process

a) The Subsidiary Hypotheses

Subsidiary Hypothesis 1.1

This hypothesis deals with the existence of procedures for forecasting waste quantities. The orthodox hypothesis states that established procedures exist, while the alternative version states that there is no established procedure.

The evidence supports four conclusions. Firstly, many officers are capable of producing forecasts of the quantity of waste which will arise in their locality. These tend to be aggregate forecasts and are often couched in terms of recent past behaviour. No change in the foreseeable future, or a fixed percentage growth rate, are examples of the kind of forecast often quoted. This may be evidence of anchoring, or a way of coping with uncertainty about current levels of waste. A minority of officers report that forecasting is impossible. Examination of this statement typically reveals that if a forecast exists, it is merely a statement that major changes in waste quantity are possible.

The second conclusion which the evidence supports is that forecasts are generally subjective. Further there are no specified forums in which these forecasts are produced. Officers typically find questions such as "who forecasts, and when and where are forecasts produced?", difficult to answer. It therefore seems better to think of forecasts as "arising" rather than as being produced.

The third conclusion which the evidence supports is that the nature of a forecasting exercise is not understood. Forecasting is seen as useful only when it eliminates uncertainty. The idea that while a forecast might reduce uncertainty, its main virtue can be that it simply identifies uncertainty, is not appreciated. This links to the failure on the part of officers to recognise that all forecasts are conditional in nature and that a specification of the conditions under which a forecast will cease to be valid is an extremely useful exercise.

Finally the examination of the forecasting exercises carried out indicates that disposal/reclamation technology in use and the amount of resources available change officers' views about the value of forecasting. Use of landfill tends to be associated with a view that additional forecasts of, for example, waste composition are irrelevant, while the use of reclamation plant leads to a concern with forecasts of composition and raw material prices.

In terms of the two versions of subsidiary hypothesis 1.1 the overall conclusion seems clear. The alternative version provides the best description of what is going on. Despite the fact that forecasts are current in many authorities, it is generally impossible to identify

procedures by which these forecasts are produced and validated.

Subsidiary Hypothesis 1.2

This hypothesis deals with the pattern of use of modern management techniques, such as D.C.F. and the variety of available O.R. techniques. The orthodox version of the hypothesis states that such techniques are in use, while the alternative version takes the opposite view, and states that such techniques are not in use.

As far as extent and pattern of use are concerned, the evidence supports the following conclusions. Firstly, modern management techniques are not in such widespread use as might at first appear. The survey response, which indicates that 63% of responding counties are technique users, paints an unduly optimistic picture. Follow up discussions and interview evidence indicate that in fact the user is often an outside consultant, and that technique use tends to be a one off exercise. Only in the case of the simplest technique, D.C.F., which according to the survey is also the most commonly used, does the evidence indicate continuing use by officers. However the evidence also indicates that the method of application of this technique is often inappropriate.

The evidence also supports the conclusion that there are major barriers in the way of successful use of management science techniques. In part these barriers relate to the lack of technical and computer skills on the part of staff. However the more fundamental barriers relate to data collection problems. Use of management science techniques requires a

pattern of data quite different from that appropriate to more traditional management styles. Therefore new data collection procedures must be introduced. Any attempt at such an exercise is likely to founder on the fact that the interests of collection and disposal officers diverge and that collection officers hold much of the relevant data.

A final conclusion supported by the evidence is that the difficulties of making use of modern management science techniques tend to lead to a reaction in favour of simple models using crude data. Unfortunately, the adoption of simple models does not appear to have been justified by any comparison of the costs of introducing an improved data collection system, with costs due to poor decisions caused by the use of simple models. The mere appearance of data collection costs has been enough in itself to generate the reaction.

The overall conclusion has to be that the evidence supports the spirit of the alternative version of this hypothesis. The appearance of examples of use of management science techniques should not mask the fact that officer involvement is limited, and where present, often misdirected. The boost to management efficiency which reformers looked for from management science techniques has yet to appear.

Subsidiary Hypothesis 1.3

This hypothesis deals with the question of whether or not reclamation technologies are considered by officers when they are choosing which technology to adopt. The orthodox version of the hypothesis states that reclamation technologies are considered: the alternative version states

that they are not. It is worthwhile re-emphasising the difference between a disposal and a reclamation technology. The distinction is not simple since even landfill of untreated waste has reclamation aspects: in the long term either land for building or gas fuel may be produced. However here the term reclamation technology is used in the more traditional sense of removing part of the waste stream prior to landfill.

There is evidence that preparation of refuse derived fuel, and extraction of metal from the waste stream are both receiving attention. However it is clear that availability of landfill is a crucial factor in determining whether or not reclamation is considered. The tendency is for technology choice to start with the issue of landfill availability, and also to stop there if capacity is available. Only if tipping capacity seems likely to be inadequate does attention shift to bulk reducing technologies including reclamation. It should be noted that in the past inadequate landfill capacity usually led to the use of bulk incineration. However recently this has not been the case. This may be due to the emphasis on reclamation in the Control of Pollution Act as well as to the fact that incineration has proved unreliable and expensive.

Overall then the evidence supports the letter of the orthodox version of this hypothesis. Reclamation is being considered as a waste management technology. However the point must be made that the process of evaluation makes it less than likely that a reclamation activity will be undertaken. Officers clearly see reclamation as high cost, and furthermore define the relevant set of costs and benefits in such a way as to disadvantage the option.

Subsidiary Hypothesis 1.4

This hypothesis exists only in the alternative hypothesis set. It states that the Control of Pollution Act is seen as only requiring production of a document. In other words, the hypothesis deals with the possibility that planning is seen as synonymous with production of a planning document.

The evidence supports the conclusion that although belief in the link between planning and document production is widespread, the Control of Pollution Act cannot be held to blame. Although it has generated a number of one off planning activities, so have other events, notably local government reorganisation itself. While the Control of Pollution Act has not been sufficient to generate a continuous planning activity, it has at least generated a recognition of the need to repeat the activity at intervals.

Overall, document production appears to have been preceded by some attempt to plan. The activity may have been limited, but the document has typically been seen as something which planning can produce rather than as something requiring an activity which might as well be termed planning. Therefore the alternative hypothesis does not receive complete support.

Subsidiary Hypothesis 1.5

This hypothesis deals with the existence, and degree of development, of data collection activities. The orthodox hypothesis is that such activities exist, while the alternative version is that any such activities are at best crude and intermittent.

The evidence indicates that data collection activities within districts are limited. Cost data are held either in extremely disaggregated form by transport departments or in highly aggregated form by collection departments. Furthermore, attempts to collect activity data to associate with costs are extremely rare. The evidence also indicates a lack of knowledge of waste quantities, whether by weight or volume. Weighbridges are expensive pieces of equipment, and their availability/unavailability has had a major impact on data availability. However, the field studies indicate that approximate waste figures can be generated by using "unusual" units e.g. bins.

The evidence supports two additional conclusions. Firstly, the management style of the disposal group has a major impact on whether or not available data is seen as adequate or inadequate. Examination of attitudes towards districts' data shows that whether or not a county is receiving data has no impact on its degree of satisfaction with the data set available. What does have an impact is the presence in use of modern management techniques. Users of O.R. type techniques are far more likely to find the data set inadequate than non users of such techniques. Secondly the evidence indicates that the Control of Pollution Act has elevated the status of data collection activities, particularly those relating to industrial waste.

As an overall conclusion, the alternative version of the hypothesis is clearly supported. Data collection activities, where they exist, are both crude and intermittent.

Subsidiary Hypothesis 1.6

This hypothesis deals with the issue of whether or not a county has a choice of sites at which to locate disposal/reclamation facilities. The orthodox version of this hypothesis states that a wide variety of sites is available to the county authority. The alternative version states that such sites are few and far between.

The evidence indicates that county staff feel that their choice of disposal sites is constrained by several factors. Apart from financial problems these factors include difficulties in obtaining planning permission, the activities of environmental groups and water authorities, and finally a shortage of available void. The evidence also indicates that counties are facing a need to open new disposal facilities and that therefore these constraints cannot be ignored.

Overall the evidence clearly supports the alternative version of this hypothesis. Counties do not see themselves as having a wide choice of available sites.

Subdidiary Hypothesis 1.7

This hypothesis deals with the confidence which can be assigned to estimates of present and future costs and waste quantities available to county waste disposal groups. The orthodox hypothesis states that estimates and forecasts have tight confidence intervals around them while the alternative hypothesis argues that a high degree of uncertainty is present.

The evidence indicates that cost estimates themselves are often not available and this inability to quote a central estimate seems a clear indication of high uncertainty. A similar situation seems to hold for forecasts of waste quantities as far as some officers are concerned. Furthermore, even though many officers are capable of stating a forecast, the range of likely alternative outcomes is difficult to ascertain. A major cause of this seems to be the attitude to forecasting held by officers; forecasting is seen as a way of removing uncertainty rather than of exploring it. Consequently a forecast figure tends to be endowed with an unwarranted certainty. The evidence also indicates that exercises designed to identify alternative likely outcomes are not encouraged. Their existence would of course challenge the prevailing view of what forecasting is about.

The field studies highlight two occasions on which an attempt was made to calculate costs and to produce forecasts. Absence of precision in these estimates cannot be put down to want of trying. However in the case of both field studies, cost estimates were crude in the extreme. A lack of data collection activities, and the inappropriateness of those data series actually held, led to cost estimates that owed more to a priori reasoning than to evidence. Similar problems hindered forecast production. Historical data series proved difficult to find, and indeed even current waste quantities proved difficult to calculate. No change, seemed to be the forecast most acceptable to county staff in each situation, but credible arguments for both increase and decrease in waste quantity were easy to develop,

Once again the burden of the evidence clearly supports the alternative version of the hypothesis.

Subsidiary Hypothesis 1.8

This hypothesis appears only in the alternative set. It deals with reactions to the fact that there is a high degree of uncertainty about costs and waste quantities. Had the alternative version of hypothesis 1.7 been rejected, then this hypothesis would also have fallen. However, given that alternative hypothesis 1.7 was not rejected, the reaction of participants in the waste management process to uncertainty is open to discussion.

During discussions of hypothesis 1.1 and 1.7 it has already been argued that officers tend to ignore uncertainty and proceed as if estimates and forecasts have tight confidence intervals. Further evidence for this is that economic evaluation by officers does not routinely test solutions for sensitivity to changes in cost estimates. However it should be remembered that some officers do attempt to introduce measures called flexibility and robustness into evaluation of strategies and alternatives. Both these measures reflect an attempt to cope with uncertainty about the future without having to quantify that uncertainty to any extent. It is therefore possible to identify two responses to the presence of uncertainty; some officers ignore uncertainty and endow estimates with spurious precision while others attempt to build flexibility and robustness into the waste management systems they operate.

This second response involves an explicit cost, and there is no evidence that this cost has been compared with the costs involved in reducing the uncertainty inherent in available forecasts. Further the confusion and how to measure robustness and flexibility which the interviews identified must also be noted. However despite these weaknesses in procedures it is clearly not the case that alternative hypothesis 1.8 can be regarded as a totally adequate description of the analysis process.

b) The Major Hypothesis

The subsidiary hypotheses so far discussed help to paint a picture of the style of analytical process in operation in the English counties. They fill in the detail which is required before a valid judgement can be made about the relative merits of the orthodox and alternative versions of major hypothesis 1. This hypothesis states in its orthodox form that there is an analytical process in operation in waste management groups in the English counties which bears a strong resemblance to rational planning. The alternative form of major hypothesis 1 argues that if an analysis activity can be identified it will rather bear a strong resemblance to Lindblom style incrementalism.

As has been argued it is difficult to find evidence that the type of activities identified in the analysis circle are being carried out. Overall the evidence seems to support the conclusion that analysis activity is subjective and unstructured. Furthermore during whatever analysis does go on there seems to be a tendency to look first at whether existing activities can be continued. In other words, analysis

is backward looking rather than objectives orientated. Finally, little evidence can be found that implementation monitoring proceeds in such a way that future decisions benefit from past experience. Taking these three facts into account the conclusion has to be that a rational style of analysis is not operating in the English counties. The orthodox version of major hypothesis 1 can be rejected.

Unfortunately the evidence also supports rejection of the alternative version of major hypothesis 1. It is true there is evidence of simple incremental decision making, but there is also evidence that officers have in mind system goals however poorly they are reflected in analysis and decisions. It should also be recalled that during interviews officers clearly indicated that they saw rational planning not only as a style of activity which should go on, but also as the style of activity which is going on. There is, to be sure, a mismatch between officers' aspirations and their achievements, but there is no evidence that incrementalist planning and analysis as defined by Lindblom, even if it is going on, is going on intentionally.

A better interpretation of the evidence seems to lie between the extremes of rationality and incrementalism. It seems that officers desire to plan rationally, but have only a superficial understanding of what the term implies. Furthermore they have little knowledge of the tools and techniques available to put rational planning into operation. Therefore when faced with constraints such as time, manpower and lack of information they come to a stop and of necessity fall back on something which resembles simple incrementalism. However this should not mask the fact that their aim is not incrementalism and that their underlying ambitions seem fundamentally inconsistent with that approach.

In conclusion then the evidence seems to support neither rationality nor incrementalism. Rather it seems to support the view that planning is an attempt at rationality which is tightly constrained by available resources. It is important to recognise the validity of this intermediate position when proposing improved methods of planning and analysis.

11.3 The Impact of Separation on Collection and Disposal

a) The Subsidiary Hypotheses

Subsidiary Hypothesis 2.1

This hypothesis deals with the existence of economies of scale, either engineering or otherwise, in English county waste disposal operations. The orthodox version argues that scale economies exist, while the alternative version questions their existence.

One of the reasons for the reform of local government was the search for economies of scale. Yet it should be remembered that there was little evidence to support the view that such scale economies were available. Rather it was the case that the reformers conformed to a climate of opinion which held that big was beautiful. However as has been argued earlier, more recent analysis has shown that a priori arguments for the existence of economies of large scale operations are of dubious validity. Therefore a key question is whether large scale operations have captured economies.

In fact it is difficult to find examples of large scale facilities within the waste disposal operation. Rather than establish county wide facilities, disposal authorities have chosen to operate as if counties are simply a linked collection of districts. Physical barriers to waste movement in part account for this, but it is clear that political pressure exerted by district councillors has also played a part. It is surely also relevant to the question of scale economies that at no time during the interview phase of the research did county staff even mention the benefits of large scale operation, achieved or waiting to be achieved. It did not seem to be an issue of concern.

What evidence there is then would seem to indicate that engineering economies have at very least not been captured. Furthermore given the quality of available cost data it is difficult to imagine any such opportunities being identified and pursued. Overall, given the weakness of the a priori arguments, the alternative version of the hypothesis seems to be best supported. There remains of course the possibility of non-engineering scale economies, but they are perhaps best discussed in the context of the next hypothesis.

Subsidiary Hypothesis 2.2

This hypothesis complements the preceding one. The orthodox version argues that whether or not economies of scale exist, there is no evidence of diseconomies. The alternative version however argues that evidence of diseconomies of scale can be found.

The obvious source of any diseconomies is management's inability to cope with large scale operations. Perhaps management can't cope with the

increased volume of decisions which have to be made, or perhaps although decisions remain few in number, their complexity has increased. There is evidence of both phenomena in waste management. Volume pressure appears because disposal groups typically contain few staff and there are many operating and site licensing problems to cope with before system development decisions can be given attention. Complexity stems from several factors: the number of waste sources involved has increased; the objective function now involves trade offs between county and district and district and district; and finally a greater volume of data has to be processed. County response to these factors has typically involved use of outside consultants and/or the adoption of simple models such as compensation formulae.

It is also true to say that complexity has increased because the environment of disposal officers has become more uncertain. However this seems to have less to do with scale than with the organisational arrangements which accompanied the increase in the size of the disposal unit.

As with the case of economies of scale, the discovery of diseconomies is made difficult by the poverty of the cost data available to the investigator. Examination of the pattern of a long run average cost curve is difficult if even rudimentary cost data are lacking. However indirect evidence supports the view that there is a risk of such diseconomies, and the state of the analysis process seems to confirm that they do in fact operate.

Subsidiary Hypothesis 2.3

This hypothesis exists only in the alternative set. It argues that any interaction between disposal and collection decisions is being coped with by simple rules of thumb rather than by negotiation and co-operation.

As far as lack of co-operation goes, the evidence seems clear. Contacts between county and district officers are informal, infrequent and deal mainly with operational issues. County officers do not attempt to involve districts in waste planning but rather see district officers and councillors as people who will be shown the complete plan. As the case studies make clear, any involvement would be complicated by perceived conflicts of interest.

In order to reflect the district viewpoint in their analysis, county officers adopt a variety of shortcuts. Some handle the problem by ignoring it; the objective function to be maximised is simply defined to exclude costs and benefits that appear in district operations. Others hand over the problem to outside consultants who either import a picture of county/district interactions in their own computer model, or try to overcome the lack of relevant communication between county and districts by personal contact. Finally some counties negotiate a compensation formula with districts. Such a formula calculates cash compensation to be paid to districts if county decisions involve an increase in the distance travelled by collection vehicles.

No examples were found of counties involving districts in the analysis of disposal options. The volume of comment testifying to the adequacy of contacts between counties and districts should not be allowed to mask this. The contacts simply do not deal with relevant issues. The evidence then seems clear. This hypothesis is supported.

Subsidiary Hypothesis 2.4

This hypothesis deals with the ability of districts to adjust collection procedures in the light of disposal decisions in order to control costs. The orthodox version states that such adjustments are possible while the alternative version argues that there are problems.

Direct evidence on this hypothesis comes from the field studies. Both make clear the views of district officers involved with round re-organisation. In each case it is evident that collection crew requirements are viewed as a constraint. Wage levels built into existing bonus and collection round arrangements are almost target levels, so new round structures tend to leave take home pay at least as high as before. Given that the survey indicates that labour force constraints are seen as important by many collection authorities, the subjects of the field studies are perhaps not unusual.

Non wage costs pose a different problem. Here the lack of knowledge which has already been commented on would seem to pose a barrier to a cost reducing decision. Mileage related costs would seem the only costs likely to reduce and these automatically rather than as a consequence of decisions by district officers.

Overall then, the alternative version of the hypothesis is supported by the evidence. In turn this implies that county officers might simply be reflecting reality in adopting simple distance based cost functions in their analysis.

b) The Major Hypothesis

Major hypothesis 2 makes a general statement about the consequences of the impact of the separation of collection and disposal on the analytical process. The orthodox version states that either the two operations can function independently of one another or that necessary forms of co-operation have been established. The alternative version questions both statements. It was argued in Chapter 10 that the two functions are linked and that co-operation is absent. This second point is emphasised in the discussion of hypothesis 2.3 in this Chapter.

However there is a further point which needs making in relation to the scale economies issue. It has been argued that scale economies have not been achieved and that in fact diseconomies of scale have appeared since reorganisation. However these phenomena are due in part to the organisational arrangements which accompanied the increase in scale and not just to the scale factor. One barrier to the use of large scale facilities which has been identified is the view held by county staff that a county is a set of parts each of which needs its own disposal facilities. The existence of any kind of district level with elected councillors would probably have generated such a view. After all, tip sites and indeed all disposal operations, are likely to generate local

opposition, and a reasonable defence is that only local waste is dealt with at a local site. However the fact that the districts collect local waste and by and large take it to site can only have emphasised the problem to districts and hence reinforced the county view.

It has also been argued that increased scale has increased the complexity of decisions. However once again organisational factors have contributed to the problem. A large scale collection operation run by the county would have left officers with access to collection costs. They would also have had the power to improve costing procedures when the need became apparent. The county/district split has robbed them of both access to data and ability to improve data collection processes. A further contribution to complexity has come about because county officers face an environment which includes additional decision makers, district officers and councillors, over whom they have no control, and who can have an impact on the performance of the disposal operation. A different organisational structure could have removed this additional element of environmental uncertainty.

In conclusion there can be no doubt that the collection/disposal split has an adverse impact on the working of the analytical process in waste management. It seems reasonable to argue that many of the benefits of large scale operation anticipated by reformers have been lost because of this particular arrangement.

11.4 Issues of Democracy

a) The Major Hypothesis

In its orthodox form this hypothesis states that the analytical process in use in waste management enhances the democratic nature of local government. In its alternative form the hypothesis argues that the analytical process hampers democracy by placing barriers in the way of elected representatives who wish to participate in the analysis. There are no subsidiary hypotheses associated with this major hypothesis.

The evidence supports the view that officers participate in the analysis process while councillors and interest group representatives do not. Officers define the content and timing of any analysis and present the results to councillors. Councillors although outside the process do have power of veto. Officers recognise this residual power and see part of their job as "getting round it". This they do by emphasising the technical nature of analysis and by validating analysis by use of outside consultants and mathematical models.

Overall there is no evidence that anything approaching the electoral chain of command theory of democracy is in operation, and the form the analytical process takes may be one reason for this. Therefore the effectiveness of the waste management activity cannot be guaranteed.

11.5 Differences Between Types of Authority

a) The Major Hypothesis

In its orthodox form this hypothesis states that metropolitan, London and Shire authorities face different problems and have responded with different analytical processes. The hypothesis deals with both upper and lower tier authorities. The alternative form of this hypothesis is that all upper tier authorities face similar problems and have responded in similar ways, and that the same is true of all lower tier authorities. The main block of evidence which is relevant to this hypothesis comes from the survey activity.

As far as upper tier authorities are concerned the evidence indicates that in terms of need to open new disposal facilities and constraints on that activity, type of authority is not a useful explanatory factor. The survey found that the need to open new facilities is common, and that differences in constraint rankings within groups are usually as important as those between groups. The only significant difference relates to concern with the requirements of the water authorities. Shire counties show more concern here than others. The evidence does however indicate that metropolitan counties respond to these problems in a different way. Formal contact between county and district officers, receipt of data from districts, and use of modern management techniques, are all more common in metropolitan than in Shire counties. There is also some indication from interviews that treatment prior to landfill is of more concern to the metropolitans, and that as a consequence they are more concerned with data availability.

The analysis of data on second tier authorities indicates that by and large problems are ranked in a similar fashion by different types of authority. However there is some indication of differences in data availability and data reporting to county authorities. Overall the metropolitans, including here the London boroughs, seem more data orientated. This confirms the findings of the survey of upper tier authorities.

Overall then different types of authority do not appear to be facing different problems in the waste management area, but there is some evidence that style of response to these problems may differ. However difference in style of response does not automatically imply differences in adequacy of response. In conclusion both versions of the hypothesis receive support but with respect to different issues.

11.6 An Overview of the Conclusions

a) A Chance in Viewpoint

So far the complex area of waste management has been studied by separating out particular issues. The analysis circle and the hypotheses sets have both been used for this purpose. However the analytical tractability which this approach offers is only achieved at a cost. The fact that one event such as local government reorganisation has many consequences is hidden, and the fact that some of these tend to cancel out each other or other government actions is also lost.

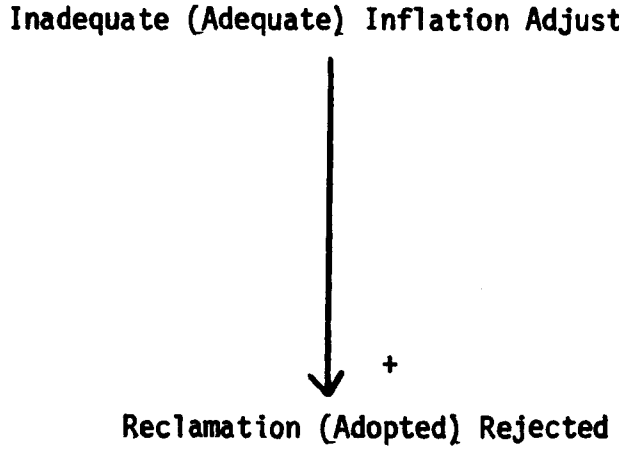
This section remedies these shortcomings of the analytical approach by attempting to show the "mechanisms" at work in the waste management area and their interactions. It must be emphasised that no new evidence or conclusions are presented. All that is involved is a representation of the material in Chapter 10 to emphasise interactions between factors. The vehicle chosen for this representation is a cognitive map.

b) Cognitive Maps

A cognitive map is a diagram showing relationships, causal and non causal, between concepts. A key feature of the approach is that it attempts to make the meaning of a concept clear by identifying the alternative or opposite of the concept. So, the concept of an integrated waste collection and disposal function is paired in the map by its opposite, a separation of the collection and disposal operations. Each concept then can be thought of as having a positive and a negative element. Two questions therefore arise; which element should be thought of as positive and which negative, and how can they be distinquished in the map. In Figure 11.6.1. the positive element is taken to be the current situation and the negative element is shown in brackets. Therefore the entry on the map "Separation (Integration) of Collection and Disposal" means that separation of collection and disposal is the current state, and integration is the opposite state, the negative element.

A cursory examination of Figure 11.6.1. raises a further question. Some elements in the map e.g. "Councillor Involvement" don't appear to be in pairs. Why? In fact only the positive element of the pair has been

explicitly identified. "Councillor Involvement" should be interpreted as "presence of...." or "more of...." with the implicit opposite being "absence of...." or "less of....". In the map, concepts are linked by lines e.g.



The arrow head on the line indicates that this is a causal relationship and also the direction of this relationship. The associated (+) indicates that the link goes from positive element to positive element or from negative to negative. So this mini-map says that inadequate inflation adjustment leads to reclamation being rejected, and also that adequate inflation adjustment will increase the amount of reclamation. As was said earlier, the map merely restates earlier text. This particular line of argument has been summarised in Chapter 10, beginning page 342. A (-) next to an arrow head indicates that the link goes from positive element to negative element or from negative to positive.

One small section of the map involves links represented by straight lines. The absence of arrow heads indicates that the relationships indicated are not causal but merely involve association.

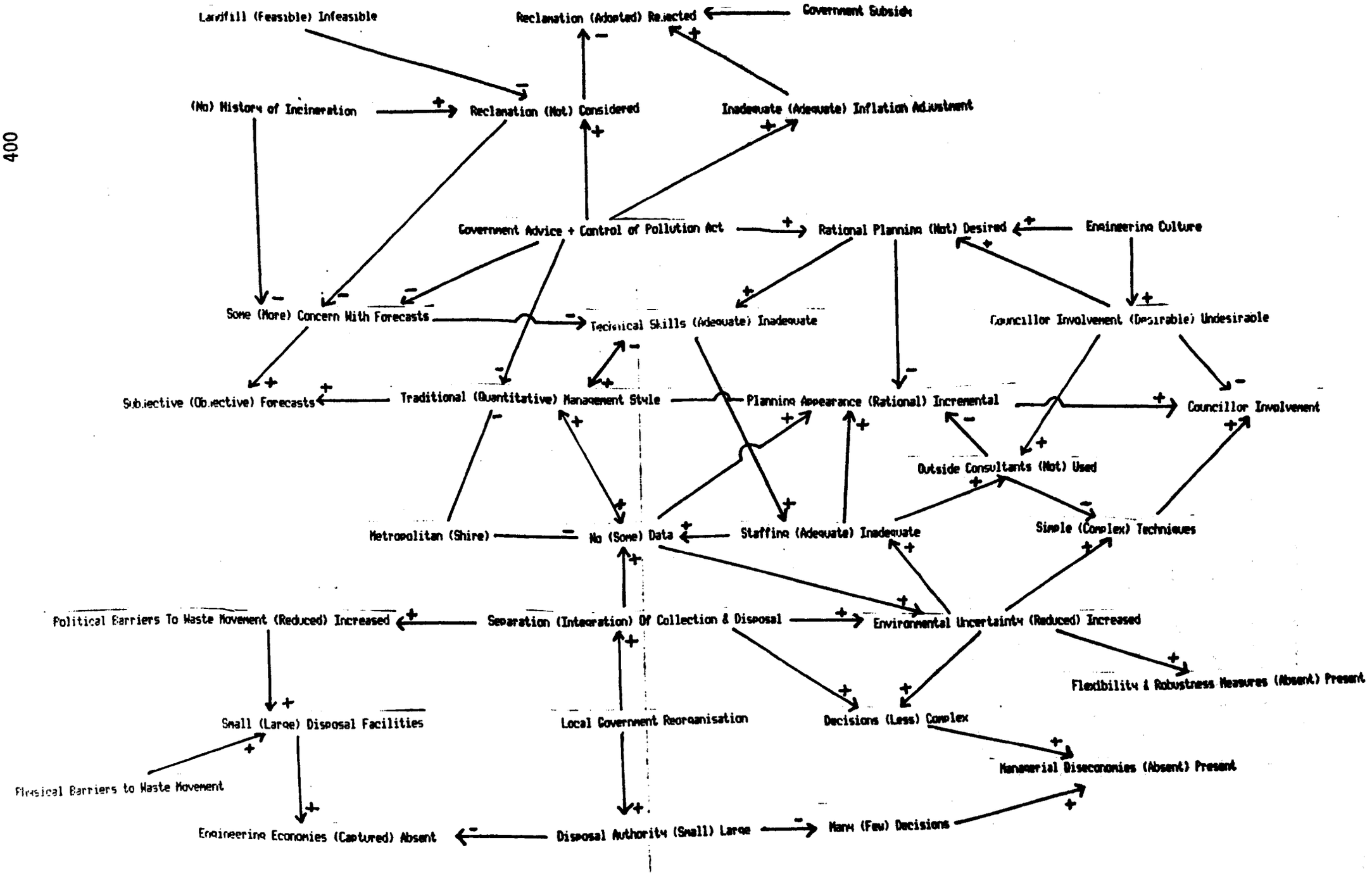


Figure 11.6.1

SUMMARY OF CONCLUSIONS

c) The Waste Management Map

Figure 11.6.1. shows some important concepts and links involved in the process of waste management. There has been no attempt to include all relevant links. Hence the map underestimates the degree of interaction involved. However completeness would have generated complexity and incomprehensibility. An examination of the earlier chapters of this thesis will identify excluded relationships and concepts.

The map has been drawn in such a way as to emphasise the impact of central government actions and advice. The impact on analysis activity, reclamation, economies of scale, and councillor involvement have been emphasised. Thus the major elements of the first three hypothesis blocks are included. The fourth hypothesis block, the existence of differences between shire and metropolitan authorities, is also represented, but it does not involve causal links and hence does not generate interactions.

d) Interpretation of the Map

To assist the reader in interpreting the map some important interactions will now be described. One relatively self contained aspect of the map deals with the issues of economies of scale (see p.366-369). Local government reorganisation is shown as having consequences for both scale of authority and organisational structure and these in turn are shown as having opposite effects on the capture of engineering economies of scale. It has been argued earlier that the structural effect dominates the scale effect. As far as managerial diseconomies go, the scale and structure effects are shown as complementary, both leading to the presence of managerial diseconomies.

The map shows local government reorganisation having a further effect. It is shown as impinging on analytical process, and management style in general, through its impact on data availability and environmental uncertainty (see p.362-366). However central government advice and the requirements of the Control of Pollution Act play a role here also. Essentially the government demands rational, quantitative analysis and at the same time puts barriers in the way of this style of activity.

One response by disposal officers to these conflicting requirements is seen to be the use of outside consultants (see p.345-346). However this feeds through to model complexity and hence on to councillor involvement (see p.371-372). The map emphasises that councillor involvement is not welcomed by disposal officers. "Engineering Culture" is used as a shorthand for the set of ideas which generate a "leave it to the expert" attitude.

The map also identifies causal links relevant to the reclamation issue. Once again government actions are seen to counteract each other.

11.7 The Next Step

a) Implications for Reform

This chapter has summarised in two different forms the conclusions reached about the analysis activity currently operating in the waste management area. Several shortcomings in the process have been identified and their sources have been examined. The nature of a more satisfactory analysis process is discussed in the next chapter.

12.0 RECOMMENDATIONS

12.1 The Desirability of an Analysis Activity

a) Diagnosis

The evidence seems to support the conclusion that there is only a limited analysis/planning activity being carried out in waste management groups in the English counties. The nature of the analysis process is not well understood by the participants and relevant activities are infrequent and ill defined. Furthermore the evidence indicates that the participants in the process are principally officers who try to implement the viewpoint of the professional engineer rather than to operate as public servants. The emphasis on engineering stems from initial skills and from the orientation of the Institute of Solid Waste Management. The Institute's bias is evident in both its exam syllabus and in the contents of its journal.

b) Consequences

The form of the analytical process in operation has several unfortunate consequences. Firstly, it hampers the working of the democratic system. Access to the process is typically denied to councillors and to the representatives of interest groups who might, in the absence of councillors, ensure that the interest of the local community are served. There is therefore a strong case for arguing that as far as the local community is concerned, the analytical process makes it less likely that the waste management system is effective in the sense of embodying the community's requirements.

This is not to say that officers' interests are served at the expense of those of the community. It seems that the analysis process is likely to be ineffective from the officers' point of view also. This is because the form of the process hides the sources of the uncertainty which characterises the environment in which officers operate, and hampers officers in dealing with this uncertainty. For example the limited waste forecasting activity allows/encourages officers to endow the future with a certainty it does not possess, and the exclusion of councillors makes it difficult for officers to respond effectively when political pressures overrule a technically superior solution. In counties B and G officers indicate that they felt they were not in control, and the emphasis on flexibility in the comments of other officers can be taken as evidence of a similar concern.

The analytical system is not only likely to allow ineffectiveness to appear in the waste management system. It also generates the possibility of inefficiency in the sense of an over commitment of resources. There are two reasons for this. Firstly, the concept of cost is not well understood. Analytical tools in use, and officers' attitudes assign undue importance to irrelevant cost concepts for example. Secondly the absence of representatives of the community makes it possible for the kind of excessive provision of resources that Chapman (1978) discusses to take place.

There is an important point here. In this view the conflict between democracy and efficiency which characterises the orthodox analysis of the local government system is inappropriate. For both effectiveness and efficiency, those often confused terms, democracy is seen as a prerequisite.

c) Potential Remedy

The search for effectiveness and efficiency can be assisted by several tools and aids. The concern here is with one only, an appropriate analysis/planning activity. The present state of the process acts as a barrier. The question therefore is, what form of process will pose less of a barrier or perhaps even prove beneficial? As has been indicated in the previous chapter, several possible forms for the analysis activity have been advocated. The one proposed here shares common ground with some of them.

Like rational planning it is ends to means oriented. A consideration of objectives is the driving force. Thus it has little in common with the simplistic view of Lindblom's incrementalist approach which appears in the literature. There are two reasons for adopting this viewpoint. Firstly, as Faludi (1973) says there is an inherent attractiveness in this view of the nature of planning. Participants in the current analysis process certainly reflect this, and furthermore Lindblom (1979) has indicated that it is his intention to pursue the "mind's need for a broad (and some would say 'higher') set of lasting ambitions or ideals" in the context of disjointed incrementalism. Secondly it is ends to means oriented because long term consequences of decisions are inevitable and it seems best to recognise them. Disjointed incrementalism does not remove long term consequences, it simply removes them from consideration. Whether they are attractive or repugnant is ignored. Even the simplest rules for current decisions can have quite unlooked for consequences; they can generate stability or instability, survival or destruction. These characteristics

of simple decision rules have been demonstrated using simple computer games. Waddington (1977) provides a summary of the relevant literature.

However the advocated analysis process is not entirely divorced from the work of Lindblom, in that it does not view comprehensiveness as an ideal. It recognises that comprehensiveness is not achievable, and that any attempt to embody it in any analysis will simply lead to early stages of analysis being relatively complete and later stages being skimped. Pressures of time, manpower and processing capability both human and artifical render this inevitable. Therefore it seems better that the truncation of the analysis should be planned, so that those items which benefit most from completeness of coverage are given it and those which can be handled at a crude level are treated in this way.

A final broad characteristic of the appropriate analysis process is that it should involve councillors as well as officers. However there is no intention that officers and councillors should be treated as equivalent. They have different roles to play.

d) Potential Benefits

The most obvious benefit likely to flow from an amended analysis process is that it will no longer be a barrier to the working of local democracy. It will become a tool designed to introduce effectiveness into actions. Whether it will be sufficient to generate effectiveness is of course another matter. Several studies of the link between presence of an analysis activity and organisational performance have been carried out. These include Thune and House (1970), Herold (1972) and Ansoff et.al. (1970).

Overall the studies seem mildly supportive of the idea that planning and success are linked, but obviously other factors are also relevant.

As well as effectiveness, greater efficiency may also follow from the introduction of a reformed analysis process. This is because of the role that the requirements of the community should come to play in deciding on resource provision.

12.2 The Form of an Appropriate Analysis Activity

a) Overview

This section will identify the component parts of an appropriate analysis/planning process to give content to the general idea of an activity leading from a consideration of ends to a consideration of means. However the aim is not to provide a description of the working of various quantitative techniques. Techniques are not planning and neither is quantification. Some techniques may be useful and some quantification may be helpful, but to quote Drucker (1979):-

> "...planning is not the application of scientific methods to business decisions...It is the application of thought, analysis, imagination and judgement. It is responsibility rather than technique".

Therefore the key questions relate to what should be done and who should be involved rather than to how tasks should be performed.

b) Activities, Frequency and Personnel

So far the analysis circle has been used as a framework for presenting evidence and analyses. It now becomes a starting point for the development of an appropriate analysis/planning activity for waste management. Its stages will be used to identify activities which planning should involve.

Raison d'etre

The most important question facing an organisation is the nature of its business. Waste management has been hampered by an unthinking adoption of the view that the relevant task is waste disposal. There is a strong case for saying that the task should be defined as making best use of a resource. This will encourage the view that there are a variety of possibilities available, ranging from putting suppliers of waste in touch with potential users, through reclamation by the local authority, to disposal at a landfill site. However even disposal by tipping might be viewed differently, for example as a means of reclaiming derelict land or as a means of generating gas fuel.

Such a reorientation of the activity should do two things, the second almost as a consequence of the first. Firstly, it should generate recognition that waste management is a potential provider of funds rather than simply a user of funds. Secondly, it should enhance the status of the function, particularly in the eyes of councillors. Ideally it would strip waste management of its Cinderella status.

Such a reorientation has possibly started. The Control of Pollution Act certainly attempted to shift attitudes, but further action by central government is required to indicate the nature of the task which has been delegated to the local authorities.

Measure of Effectiveness

In the analysis/planning process found in the English counties, little attention was directed to this activity. However this is inappropriate. The development of measures of effectiveness should be a significant activity. There are several dimensions of performance which should be considered. Firstly, the waste handling system must be designed to have sufficient capacity to cope with all waste arisings. This implies that attention should be directed to measuring the amount of resource extracted from the waste by any activity, to measuring any volume reduction which is brought about, and to measuring the amount of landfill capacity required by any activity. Secondly financial performance should be measured. This requires consideration of current and future cost and revenue patterns. Such data should reflect cash flows not accounting conventions and should ignore sunk costs. The emphasis here should be on which cost elements and revenue elements are relevant not on whether they should be summarised as a net present value figure or an equivalent annual cost or some other measure. A third set of measures which should be considered are those which relate to environmental impact. Typically these would include measures for noise,dust and smell as well as impact on the water supply.

Finally it seems clear that it is at this stage that consideration should be given as to how to measure robustness and flexibility. Various measures are potentially useful among which are technology reliability, and the possibility of staged development. However consideration of these measures

should take into account the fact that potentially two system characteristics are relevant. The use of flexibility as a catch all concept is to be avoided in that it masks the range of ways in which uncertainty can be planned for.

At some point target levels for individual measures and perhaps for aggregates of measures must be specified. In certain cases these targets will be simple to arrive at. Some will be automatic, for example all waste must be dealt with, and others may be specified by central government. However others may be more difficult to arrive at. This is because trade offs will not be explicit and what is achievable will not be clear. Therefore there is a case for leaving the establishment of the more problematic targets until later in the analytical process.

At this stage of the analysis process there is a clear need for the involvement of officers, councillors, and representatives of interest groups. The key consideration should not be measurability, or even reliability but validity. It is acknowledged that this kind of discussion of how to measure consequences is neither easy to initiate nor easy to carry through. There is therefore a case for saying that a facilitator should be involved. This might be someone from another area of the county's operations or an outside consultant. The point is that their skills should relate to their ability to structure this kind of debate.

The value of involving councillors has so far been argued from the point of view of the desirability of effectiveness. However there is another supporting argument. Some of the literature on local government reform deals with the issue of the quality of councillors. In part the discussion

has been no more than a statement of concern about a political challenge to a vested interest. However in part it has reflected a concern about the ability of councillors to cope with the technical aspect of a council's operations. Proposed solutions have typically involved redefining the population from which councillors can be drawn or redefining the range of functions authorities can carry out to make the job more important and therefore attractive to better people. However there is no reason why existing councillors cannot be educated to participate more effectively. It is arguable that councillor participation in a well structured forum for the purpose of deciding how to measure the consequences of actions would be a useful part of such an education.

Assigning this educative role to the analysis process emphasises the need for a facilitator to this stage of the process at least. Otherwise officers might generate acceptance of their solutions rather than debate. There is another implication of assigning this educative role to the analysis process. That is that the maximum time which should elapse before this stage of the analysis process is repeated is the length of time between elections.

Forecasting

Two activities are subsumed under this heading. These are an examination of the current state and level of performance of the waste handling system, and the production of forecasts of possible future performance levels. The aim is to identify shortfalls in performance either current or future. When measurement of current performance has been carried out and forecasts of future performance have been produced the participants in the planning

forum can discuss them and identify performance shortfalls. In doing this any important targets which were not established earlier will be defined.

In terms of performance measurement and forecasting, officers should be the principal participants. However if an important performance measure has been defined to be number of complaints to councillors, for example, councillors might also be involved. In identifying shortfalls, all participants in the planning forum should be involved, councillors and interest group representatives because without their value judgements the process cannot be effective, and officers because they can offer information about feasibility and apolitical advice. It should be noted that the aim is not to describe the current situation and provide a set of detailed forecasts. Comprehensive pictures are not the aim. The set of measures defined earlier will set limits on the size of the measurement and forecasting exercise.

The most appropriate type of forecasting exercise will change as participants become more skillful and as the environment changes. However the aim should remain that of identifying areas of uncertainty and the sources of that uncertainty. There should be an explicit model of the mechanisms generating waste and affecting the waste handling system. Again the stress is on building a model not on preparing a detailed representation of reality, and again the debate about measures of effectiveness will set limits on model size. The model need not be mathematical, a verbal exposition would suffice although a diagramatic exposition would probably be better. However it should be explicit so that it can be criticised in the planning forum. Berry (1978) offers the nucleus of such a model.

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Even with such a model in existence, the forecasting process could remain essentially subjective, and in the short and medium term probably should remain so. Objective forecasting may well be superior to subjective forecasting over long time horizons, but to introduce objective forecasting immediately might run the risk of swamping the exercise in technique manipulation. However just because the forecasting exercise remains subjective does not mean that it cannot be improved. Armstrong (1978) identifies several mechanisms that can improve the quality of a subjective forecasting exercise, in part they involve controlling the nature and extent of interaction between participants in the forecasting process, and in part they involve defining mechanisms which can be used to present forecasts. In the context of waste management, major improvements in forecasting can probably be brought about by relatively simple changes such as, making the forecasting exercise explicit, involving several participants in such a way that no one person exercises an undue influence, and emphasising that the purpose is to identify uncertainties rather than to hide them. To emphasise that admission of uncertainty is acceptable some method of presenting forecasts which emphasises multiple possible futures, such as scenario building might be useful.

There does not seem at present time much to be gained from asking for the forecasting process to involve an attempt to specify probabilities in anything but the crudest sense e.g. likely and unlikely. To do more than this would probably generate an attempt at precision which would not be fruitful.

Once alternative future have been identified, the factors which make them different can be identified. The involvement of councillors should help

to minimise the importance of uncertainty about policy values in generating different possible futures. However some will still remain because of the possibility that the political complexion of the council may change. It is the duty of officers to point this out and it is the duty of councillors to allow officers to produce contingency plans for such an eventuality. Some uncertainty will remain about choices in related decision areas. Again these may be less because of the involvement of a larger group in the analysis process. Furthermore some of those that remain may be best dealt with by inviting participation of additional people in parts of the analysis process. What uncertainty from this source is left is best dealt with by building flexibility or robustness into the waste management system. There will always be uncertainty about the operating environment remaining. Some of this it will be worthwhile resolving by one off data collection exercises, some it will be worth resolving by setting up data collection systems in recognition of the likely continuing importance of these source of uncertainty, some it will be seen best to deal with via robustness or flexibility in the waste management system.

Where new data collection exercises are set up, they will not be haphazard or aim at comprehensiveness. They will have been defined by specific needs. In this sense the forecasting exercise will serve the purpose that the quantitative model served in the two field study exercises.

Strategy Generation, Evaluation, Selection

In the light of actual and potential performance gaps which the forecasting exercise has identified, participants in the planning forum will consider ways in which the gaps can be reduced. In some cases the gaps will be

reducible by the simple application of "more of the same". In other cases the gaps will be so significant that some additional or alternative strategy must be brought into the mix. There is a substantial problem here. It is not evident that the difference between significant gaps and insignificant gaps is so easily identified. County B provided an example of an attempt to remedy a significant gap by a simple application of more of the same. It is arguable, and after discussion this view seemed acceptable to officers in county B, that a better approach would have been to try to introduce additional elements into the strategy mix.

The ability to decide when a strategy re-examination is necessary will be improved by the increase in the number of people involved in the analysis process which is advocated here. They will provide alternative points of view, and they will provide the resources necessary to allow such a re-examination to proceed. Because of the educative role which has been assigned to the analysis process, the maximum period of time between strategy examinations should be the period between elections. However given resource shortages, it is likely that problems will arise which require some form of strategic consideration far more often.

The process of strategy generation is difficult to formalise. The ability to identify opportunities relates more to personal flair than to an organisationa structure. However the adoption of the broader view of the waste management function which has been advocated makes improvement possible. So too does the involvement of more people. A wider ranging examination will be encouraged and there is more chance that a creative thinker will become involved in the process.

The evaluation of any strategies which are generated should be limited to a very broad brush exercise. Here the aim is to generate a wide ranging search rather than a painstaking examination of one or two strategies. The aim should be to compare strategic options in broad terms using the measures of effectiveness already produced. If there is a case for any emphasis on technique here, it has more to do with presentation of information than anything else. Thus discounted cash flow, for example, would appear not so much because of its own meaningfulness but because it summarises much data into a single figure. It would be used only if other summary statistics were seen to be less satisfactory.

The act of comparison and selection which also appears at this phase of the analysis process needs careful specification. Firstly, there is no need to impose the limitation that strategy has only one element. A strategy mix can be carried forward. Therefore the emphasis should perhaps be placed on weeding out non starters rather than on selecting winners. Secondly it should be recognised that evaluation and selection are political acts. They should involve community representatives. However there is no reason why officers should not be involved and indeed their involvement may be beneficial in that they can aid in interpreting data and in that they may have a longer run of experience than some councillors.

It is at this stage of the analysis process that it may become necessary to assign ranks to the various measures of system performance which have been defined. However concrete options are available so that rankings and trade offs can be specified in the light of what is feasible. This issue

of feasibility of strategy is important. The difficulty of assessing feasibility was made clear by the examples of counties B and D. To some extent the widening of participation in the planning forum should help to remove political infeasibilities, but technical questions will remain.

Alternative Generation, Evaluation and Selection

It seems likely that this will generally be a rather limited activity. This is so because it deals more with the question of where a facility should be put rather than with what the facility should be, and as has been said, most counties seem to face a finite feasible set situation. Thus the aim will often not be to optimise but merely to satisfice. However there will remain a role for this kind of activity since it is at this stage that impact on collection costs and the problem of equitable treatment of different parts of the county will become apparent. It is perhaps at this stage that councillor involvement should diminish somewhat. There is too great a possibility that they will be swayed by strictly parochial or electoral concerns. However their role as guardians against over provision must be retained in some way. Perhaps this can best be achieved by councillors being faced with alternatives produced by county and district officers among which they can choose.

It is at this stage that there is most scope for the application of quantitative techniques. However they should be those that allow for sensitivity testing, since data inadequacies are unlikely to be remedied in the short term, and they should be those that involve users rather than attempt to replace them. It may be that a discounted cash flow exercise is appropriate here. (However it should be recognised that the

field studies indicated that often this was not required). If such an approach is utilised its complexity should be taken into account. The issue of how to treat inflation has already been dealt with, but there are many other problem areas, the most important of which relates to the treatment of risk. The uniformly low risk characterisation of public sector investment which is implied by application of the Treasury Test Discount Rate is clearly not appropriate in this field.

Monitoring Implementation

This activity should be continuous. It should be the province of officers rather than councillors. Councillor involvement probably indicates that the activities of the officers are inadequate. It should deal with the broad issue of adequacy/inadequacy of the waste management system, but also with the audit of investment decisions. Concern with implementation should generate an examination of the possibility that the strategy is infeasible, however cursory, before attention is turned to a "more of the same" approach. This implementation monitoring phase will establish the actual frequency with which the various stages of the analysis process are repeated.

12.3 Implementation Problems

a) The Nature of the Remedy

It is not unusual to read of any proposal for reform that the analysis of problems which preceeds it is better developed than the direction of reforms. It may be that the reader feels that the proposal for an alternative analytical process which has been put forward can be described in the same

fashion. Perhaps it appears too general, too much an overview. There is a reason for this which relates to the philosophy of this work. The analysis has proceeded at a micro level. The problem area has not been government or management, or even local government management. It has been the analysis process in the waste management portion of local government's activities. Similarly, the specification of the detail of the alternative analysis process must also be made at the micro level. The issue is not what should all counties do. It is what should a particular county do to bring its analytical process closer to that which has been described. The current situation of a county, its history and its personnel will pose unique problems in introducing change. For this reason, the introduction of a change agent in a county who can respond to the specific situation may well be necessary.

However there are some general points about the implementation process which can be made and these will be spelt out in what follows.

b) Officers' Attitudes

Any attempt to broaden the range of participants in the planning activity along the lines suggested here is likely to run into opposition from officers. This may express itself in various ways, but because of the view which officers appear to hold about the role of councillors, it is likely to manifest itself in some form. It is possible that this opposition can be counteracted by emphasising the rational nature of the proposed process and by highlighting the role which officers can play, but this may not be sufficient. Therefore it may be necessary to introduce different personnel

into the ranks of the waste management officers as well as into the planning forum. These personnel need to be professionals if they are to have sufficient standing to influence the behaviour of their professional colleagues, but the basis of their professionalism needs to be different. The emphasis should be more on those professions where the emphasis is on responsiveness to a client's needs rather than on problem solving as such. Therefore a legal training or perhaps an accountancy training may be appropriate. The danger with introducing an accountant is that too great an emphasis may come to be placed on evaluation techniques and data collection and too little on the broad thrust of the process.

c) The Role of Consultants

There is a strong case for saying that a change agent needs to be introduced into the county waste management function. His tasks would be to identify the current state of a county's analysis activity and identify ways in which it could be developed in the direction of the appropriate process which has been defined. There is no case for saying that diagnoses and initial changes will be common across counties. For example in the case of county G the diagnosis might stress the excessive formalism and technique emphasis while in county A the diagnosis might stress the absence of any structure at all.

There is no case for using a consultant who operates as a purveyor of techniques. Data problems generally indicate that solutions offered will be spurious and in any case the emphasis should be on internal participation not on hiving off the problem to someone else. One of the aims of the revised analytical process is educative. This cannot be achieved if the activities are handed over to outsiders. In this respect

the way in which county C used its outside consultant had much to commend it; the range of the consultant's work was clearly defined. However even here the prestige of the techniques was tending to affect officers' views.

d) Structural Change

There is no case for saying that the analytical process can be reformed solely by the impact of legislation and government advice. Undoubtedly the Control of Pollution Act and Local Government Reorganisation had an effect. However at best they enabled change or put barriers in the way. As far as initiating change goes they were impotent.

The aim of government initiatives at the macro level should be to establish a framework within which change agents can operate. This may well involve a far more piecemeal approach than in the past. Rules of thumb such as "big is beautiful" are too crude to deal with the range of activities in the local government system. With this in mind it should be said that policy based on the idea that the metropolitan/shire split is informative is unlikely to be valuable in the waste management area. In this area, a reintegration of collection and disposal might be far more fruitful. There is now a case for saying that this should be at the county rather than the district level, simply because division is always more difficult than integration. Inequality of provision of landfill capacity would probably be increased if an attempt was made to share existing facilities between the districts.

It is in this area of equality of provision that waste management could probably benefit from some national initiative. Certainly there is a growing tendency for co-operation between counties to appear, but there are still many barriers facing a county which wants to export its waste to another. There is a case for saying that government action to ease sharing of facilities is necessary whatever local government unit is responsible for waste management. However this argument does not automatically lead to advocacy of a regional waste management system since as has been argued size is not the issue it is the pattern of resource availability.

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Appendix 1

DISTRICT AND COUNTY QUESTIONNAIRES

Q U E S T I O N N A I R E

F O R

T H E D I S T R I C T S

In completing the questionnaire, please tick (✓) and/or state answer wherever appropriate. In certain instances you may have to tick more than once.

PRESSURE ON RESOURCES

(1) What are the difficulties in improving collection services? (Please rank the magnitude of difficulty by placing 1 for the most difficult, 2 the next most difficult, 3, 4, 5 .... in descending order of magnitude).

	Magnitude of difficulty (1, 2, 3, 4, 5 ..... in descending order)
1. Financial Constraint	.....
2. Rapid Increase in Waste	.....
3. Manpower Shortage	.....
4. Disposal Sites or Transfer Facilities - too far	.....
5. Labour Problem	.....
6. Other (please specify)	

(2) What is the average growth rate of amount (in volume and/or in weight) of waste in your District? (Please specify percentage (%) to the nearest 1%. Answer if answers are available to you).

	Percentage (%) Increase Over Years	
	In Volume	In Weight
1. 1974-75	..... %	..... %
2. 1975-76	..... %	..... %
3. 1976-77 (Estimate)	..... %	..... %
4. 1977-78 (")	..... %	..... %

(3) What is the average growth rate of cost of waste collection activities in your District? (Please specify percentage (%) to the nearest 1%. Answer if answers are available to you).

	Percentage (%) Increase Over Years
1. 1974-75	.....%
2. 1975-76	.....%
3. 1976-77 (Estimate)	.....%
4. 1977-78 (")	.....%

COMMUNICATION

(4) What sort of information do you collect about waste in your District? (Please tick (✓) wherever appropriate and also state the frequency of collection).

INFORMATION

Amount of Waste				Cost of Waste Collection Activities*					Frequency of Obtaining Information
Volume		Weight							
Total	By Waste Material	Total	By Waste Material	Total	Cost Per Ton	Cost Per Mile	Cost Per Cu. Yd.	Other (Please specify)	

* Please refer question (5)

(5) Which department is actually collecting the cost information on waste collection activities in your District?

(6) Is your District sending to the County, information about the waste (refuse) analysis and the cost of waste collection activities? (Please also state frequency with which information is sent to the County).

	Frequency of Information to County
1. Waste (Refuse) Analysis Results	.....
2. Cost of Waste Collection Activities	.....

(7) Is the information sent to the County (ref. (6) above) accompanied by an explanation of the ways in which the figures are calculated?

1. Yes .....

2. No .....

(8) Do you consider that the process of information collection and supply to the County is:

	Yes	No
1. Time consuming but important	.....	.....
2. Time consuming and unimportant	.....	.....
3. Other (Please specify)		

(9) What form of liaison is there between your District and the County in the management of waste? (Please also state the function(s) of the liaison and the frequency of liaison occurrence).

Form of Liaison	Function(s)	Frequency of Liaison Occurrence
1. Agency Arrangement Committee	.....	.....
2. Joint Committee (District-County)	.....	.....
3. Informal District-County Personnel Interaction	.....	.....
4. Other form (please specify)	.....	.....

(10) Would you prefer a different form of liaison or more frequent liaison?

1. Yes .....

2. No .....

(11) If "Yes" to question (10), what form of liaison would you prefer?

MANAGEMENT SCIENCE TECHNIQUES

(12)* Have you ever used any of the following management science techniques in relation to the management of waste in your District? (Please also state the problems tackled and/or being tackled by the techniques).

Management Techniques	Problems Tackled and/or Being Tackled
1. Simulation	.....
2. Linear Programming	.....
3. Discounted Cash Flow	.....
4. Other Similar Techniques (please specify)	.....
	.....

* If "yes" to question (12), please answer questions (13)-(15).
If "no" " " " , " proceed to question (16).

(13) On what basis do you select the management science techniques to tackle the problems (ref. (12) above)?

(14) When did your District first introduce management science techniques in the management of waste? (Please also state whether you are currently using any of them, and, if not, please state the date of last use).

Date of First Introduction	Current Use	Date of Last Use if "No" to Current Use
.....	1. Yes	
	2. No	.....

(15) Before the introduction of the management science techniques did your District know of other Counties and/or Districts using them?

1. Yes .....

2. No .....

(16) Although your District has never used any of the management science techniques is there any intention to introduce them?

1. Yes .....

2. No .....

3. Don't know .....

(17) If it is necessary, may we visit you at a later date to discuss your response to this questionnaire?

1. Yes .....

2. No .....

Q U E S T I O N N A I R E

F O R

T H E C O U N T I E S

In completing the questionnaire, please tick (✓) and/or state answer wherever appropriate. In certain instances you may have to tick more than once.

PRESSURE ON RESOURCES

(1) For how long can your existing disposal (land-filling) sites handle anticipated future waste?

	Yes	No
1. Next One Year	.....	.....
2. " Two Years	.....	.....
3. " Three "	.....	.....
4. " Four "	.....	.....
5. " Five "	.....	.....
6. Over " "	.....	.....

(2) What are the difficulties in extending existing and/or developing potential disposal sites? (Please rank the magnitude of difficulty by placing 1 for the most difficult, 2 the next most difficult, 3, 4, 5 .... in descending order of magnitude).

	Magnitude of difficulty (1, 2, 3, 4, 5 ..... in descending order)
1. Financial Constraint	.....
2. Planning Permission Rules for Land Use	.....
3. Absence of Land-extraction Industry i.e. lack of mining holes	.....
4. Environmentally-concerned lobby	.....
5. Other (please specify)	

(3) Are you obtaining information from the Districts about (a) the amount of waste collected in the Districts, and/or (b) the cost of waste collection activities in the Districts? (Please list the Districts involved, tick (✓) the appropriate category of information and give the frequency with which the information is provided, e.g. quarterly, yearly, etc.).

INFORMATION

Name of District	Amount of Waste				Cost of Waste Collection Activities					Frequency of Obtaining Information
	Volume		Weight							
	Total	By Waste Material	Total	By Waste Material	Total	Cost Per Ton	Cost Per Mile	Cost Per Cu. Yd.	Other (Please specify)	

(4) Is the information obtained from the Districts (ref. (3) above) accompanied by an explanation of the ways in which the figures are calculated?

1. Yes .....

2. No .....

(5) Is the information you are obtaining from the Districts adequate for the management decision making you do, e.g. decisions in the management of disposal of waste?

1. Yes .....

2. No .....

(6) If "No" to question (5), in what ways is information from the Districts not adequate and what additional information do you require?

(7) Which form of liaison is there between your County and the Districts in the management of waste? (Please also list the Districts and the frequency of liaison occurrence).

Name of District	Form of Liaison and Frequency of Liaison Occurrence							
	Agency Arrangement Committee	Frequency	Joint Committee (County-District)	Frequency	Informal County-District Personnel Interaction	Frequency	Other Form (Please specify)	Frequency

(8) Would you prefer a different form of liaison or more frequent liaison?

1. Yes .....

2. No .....

(9) If "Yes" to question (8), what form of liaison would you prefer?

MANAGEMENT SCIENCE TECHNIQUES

(10) Does your County do any waste (refuse) analysis? If "Yes", when did you start doing it and how often do you do it?

	Year of Starting	Frequency of Doing Waste Analysis
1. Yes	.....	.....
2. No	.....	.....

(11)* Have you ever used any of the following management science techniques in relation to the management of waste in your County? (Please also state the problems tackled and/or being tackled by the techniques).

Management Techniques	Problems Tackled and/or Being Tackled
1. Simulation	.....
2. Linear Programming	.....
3. Discounted Cash Flow	.....
4. Other Similar Techniques (Please specify)	.....
	.....

* If "Yes" to question (11), please answer questions (12)-(14).
If "No" " " " , " proceed to question (15).

(12) On what basis do you select the management science techniques to tackle the problems (ref. (11) above)?

(13) When did your County first introduce management science techniques in the management of waste? (Please also state whether you are currently using any of the techniques, and, if not, please state the date of last use).

Date of First Introduction	Current Use	Date of Last Use if "No" to Current Use
.....	1. Yes	
	2. No	.....

(14) Before the introduction of the management science techniques did your County know of other Counties and/or Districts using them?

1. Yes .....
2. No .....

(15) Although your County has never used any of the management science techniques, is there any intention to introduce them?

1. Yes .....
2. No .....
3. Don't know .....

(16) If it is necessary, may we visit you at a later date to discuss your response to this questionnaire?

1. Yes .....
2. No .....

APPENDIX 2

PLANNING QUESTIONNAIRE

QUESTIONNAIRE ON PLANNING FOR WASTE DISPOSAL

Please circle your answers YES/NO

The page numbers refer to the relevant parts of the paper "Status of Waste Management Planning in the English Counties".

If you want to make any other comments on the back of the sheet please do so.

1. Do you agree with Ackoff's definition of planning (p.2) YES/NO

   If you answers NO provide your alternative definition:

   _____
   _____
   _____

2. Do you plan? YES/NO

   If you answered NO - Do you intend to plan in the future? What will your planning involve?

   _____
   _____
   _____

   It is up to you whether you complete the questionnaire.

   If you answers NO to question 1 and YES to question 2 you need NOT complete the rest of this questionnaire, but we would be grateful if you would write a short comment on what your planning involves.

   ALL OTHERS please continue.

3. What do you think the role of your department is:

   A. Waste disposer? YES/NO

   B. Waste processor? YES/NO

4. Do you identify specific measures that can be used to evaluate strategies (p.3)? YES/NO

   If you answered YES give examples:

   _____
   _____
   _____

5. Do you anticipate significant changes over the next 10 years which would affect waste disposal? YES/NO

   If you answers YES, what sort of changes?

   _____
   _____

6. In choosing your present strategy how many other options did you consider (p.4)? (Number) _____

7. When do you think it might be necessary to re-examine your present strategy? (Years) _____

8. With reference to the diagram on p.2, are there any steps in your planning process which do not appear here?

   _____
   _____

9. What part of your formal training has been most in use in planning for waste disposal?

   _____
   _____

APPENDIX 3

LANCASHIRE DATA

"WEIGHT OF WASTE BY COLLECTION AREAS"

ROUND	WEIGHT TO BE REMOVED	
B1	60.85	tonnes/week
B2	62.94	"
B3	63.66	"
B4	51.18	"
B5	68.37	"
B6	32.29	"
B7	56.11	"
B8	52.11	"
B9	71.21	"
B10	60.59	"
B11	53.82	"
B12	74.12	"
B13	62.09	"
B14	71.91	"
B15	41.79	"
B16	34.69	"
B17	64.01	"
B18	50.11	"
B19*(N)	19.08	"
B19*(S)	30.53	"
W1	51.80	"
W2	63.98	"
W3	62.93	"
W4	63.73	"
P1*(N)	14.42	"
P1*(S)	43.25	"
P2	15.28	"
F20	45.92	"
F22	49.54	"
F23	52.40	"
F24	49.74	"
F26	54.86	"
FRECKLETON	35.45	"
WREA GREEN	30.38	"
WEETON and PREESE	44.54	"
KIRKHAM and WESHAM	55.18	"
(STAINING and SINGLETON)*	23.22	"
(TREALES)*	11.61	"
GREENHALGH	20.24	"

* Single rounds have been split and total weight divided between them on the basis of relative areas.

CALCULATED ROUTE DISTANCES (MLS)

Round	Jameson	Transfer Site (1)	Transfer Site (2)	Transfer Site (3)	Clifton
Blackpool (1)	3.24 MLS	1.48 MLS	2.64 MLS	6.56 MLS	15.40 MLS
Blackpool (2)	4.56 "	0.16 "	1.44 "	6.00 "	15.00 "
Blackpool (3)	5.00 "	2.00 "	0.96 "	4.80 "	19.90 "
Blackpool (4)	6.00 "	1.60 "	0.60 "	4.80 "	13.80 "
Blackpool (5)	6.40 "	2.40 "	2.00 "	4.80 "	13.80 "
Blackpool (6)	6.60 "	1.80 "	1.20 "	4.40 "	13.40 "
Blackpool (7)	6.60 "	2.60 "	1.80 "	3.80 "	12.80 "
Blackpool (8)	6.80 "	2.40 "	1.40 "	4.40 "	13.40 "
Blackpool (9)	7.40 "	3.20 "	2.40 "	3.40 "	12.60 "
Blackpool (10)	7.80 "	3.60 "	2.80 "	3.20 "	12.20 "
Blackpool (11)	7.60 "	3.60 "	2.80 "	2.80 "	11.80 "
Blackpool (12)	9.00 "	5.20 "	4.00 "	3.40 "	12.40 "
Blackpool (13)	8.60 "	4.80 "	3.60 "	1.40 "	10.60 "
Blackpool (14)	9.40 "	5.60 "	4.40 "	3.60 "	12.60 "
Blackpool (15)	8.80 "	5.00 "	3.40 "	3.00 "	12.00 "
Blackpool (16)	9.20 "	5.40 "	3.80 "	1.20 "	10.60 "
Blackpool (17)	10.80 "	7.00 "	5.40 "	2.80 "	12.40 "
Blackpool (18)	9.80 "	6.00 "	4.40 "	2.00 "	11.60 "
Blackpool 19*(N)	3.80 "	1.20 "	2.40 "	7.20 "	16.20 "
Blackpool 19*(S)	5.20 "	0.80 "	0.80 "	5.60 "	14.60 "
Wyre (1)	1.80 "	6.00 "	7.20 "	11.20 "	19.80 "
Wyre (2)	1.60 "	4.20 "	5.20 "	9.60 "	18.60 "
Wyre (3)	2.20 "	5.20 "	6.20 "	10.40 "	19.40 "
Wyre (4)	2.40 "	3.20 "	4.20 "	8.80 "	12.20 "
Wyre (5)	3.00 "	2.80 "	4.00 "	7.60 "	16.60 "
Poulton (1)*N	4.40 "	3.20 "	2.40 "	6.80 "	15.80 "
Poulton (1)*S	5.60 "	3.60 "	2.80 "	4.40 "	13.40 "
Poulton (2)	5.20 "	3.60 "	2.80 "	5.60 "	14.60 "
Fylde (20)	12.00 "	8.40 "	6.80 "	3.60 "	8.00 "
Fylde (22)	11.40 "	7.40 "	6.80 "	4.00 "	9.20 "
Fylde (23)	13.60 "	10.20 "	8.80 "	4.80 "	7.20 "
Fylde (24)	12.40 "	8.40 "	7.60 "	4.80 "	9.20 "
Fylde (26)	14.00 "	10.40 "	9.20 "	4.80 "	5.60 "
Freckleton	16.40 "	12.80 "	12.00 "	8.00 "	1.60 "
Wrea Green	13.20 "	10.00 "	8.00 "	4.20 "	4.00 "
Weeton and Preese	10.00 "	6.60 "	4.80 "	3.00 "	5.60 "
Kirkham and Wesham	11.20 "	10.00 "	9.40 "	6.40 "	5.60 "
Staining,Singleton	7.20 "	6.00 "	6.40 "	6.60 "	10.60 "
Treales	12.40 "	11.60 "	10.40 "	8.20 "	5.20 "
Greenhalgh	9.00 "	8.00 "	7.20 "	5.60 "	7.60 "
T.S(N)1	4.80 "				15.20 "
T.S(M)2	5.60 "				13.20 "
T.S(S)3	9.20 "				10.00 "